CHEMICAL & METALLURGICAL ENGINEERING

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Fixing Wages and Standards Of Living by Statute

IT WILL NOT be difficult for reasonable men to follow the logical mental processes of the Railroad Labor Board in reaching the conclusion that "the living wage" theory is untenable. The reader will recall the demand made on the board by A. C. WHARTON, labor member, to establish a "living wage" for railroad workers regardless of wages paid for similar work in other industries. He wanted to disregard all economic laws and considerations and determine a wage that would enable a family of five to live on an arbitrary standard.

It is much to the credit of the Labor Board that it has declined to yield to the demand for any such artificial method of fixing wages. Statutory determination of a standard of living and arbitrary setting of wages for a group of men without regard to conditions under which similar groups are working are fallacious ideas that cannot find acceptance. Standards of living result largely from personal aspirations, and wages must be determined on a basis of service with due regard for relative values. Standards of living are improving in this country, but, as the Labor Board wisely remarks, the movement must be gradual and "cannot be consummated in the twinkling of an eye by artificial expedients."

Enlightened Labor Policy

WITHIN the last week two stories have reached us which tell a whole volume of stories. A young chemical engineer in charge of a manufacturing unit wrote: "We are having all kinds of trouble with labor. Every morning brings a long line of colored gentlemen with employment cards to be made out and an equally long line of men getting their time. It's got so that you ease up to a kindly ace of spades and ask him if he would mind rolling a few ounces. He will usually say, Yes, he would mind!"

With that experience fresh in our minds we asked another man, a plant manager, whether he had labor troubles. "Why, no!" he replied. "We haven't had any for years!" Then it developed that this company had realized that its location was disagreeable and that in order to hold its men it would have to make the work and the living conditions attractive. This the company has done in so far as possible and its labor turnover is less than 5 per cent!

How this has been accomplished is an interesting story which some day may be told. In any case the sooner industrial men realize that satisfied labor is an asset and move in that direction the better it will be for them.

The best example of what can be done is that of the Philadelphia Rapid Transit Co. A few years ago the company was bankrupt. Today it is healthy. The one difference is that the loyalty of the employees has been enlisted. Today they realize that their interests and those of the company are identical. A wise executive has seen to it that this fundamental principle has been adhered to. This principle must be steadfastly and sincerely followed, otherwise the distrust of the worker will persist. While other companies fight strikes, the employees of the Philadelphia Rapid Transit Co. voluntarily reduce their own wages.

Is an enlightened labor policy worth while?

Packing Industry Adopts Research Program

EDITORIAL reference was made in our issue of June 7 to the research and educational program for the packing industry outlined by THOMAS E. WILSON as the development plan for the Institute of American Meat Packers. At the seventeenth annual meeting of the Institute held recently in Chicago, the plan was adopted at the close of a most interesting session in which Dean RALPH G. HEILMAN of the Northwestern University School of Commerce demonstrated the value of research and education to an industry. The specific benefits to the packing industry were discussed by such competent critics as OSCAR G. MAYER, ARTHUR LOWENSTEIN, W. D. RICHARDSON, L. D. H. WELD, ARTHUR CUSHMAN, M. D. HARDING and J. C. DOLD.

As a working program, the report of the Institute plan commission was also adopted. This recommends raising by individual volunteer subscription the sum of $50,000 a year for three years to be spent on educational and research activities. For the first year, recommendations include: the appointment of a director of research to be responsible, with adequate assistance, for the entire scientific work of the Institute; to enable the committee on practical research to handle all matters dealing with practical packing house operation, the service of a competent secretary will be required; as a start in educational work, a series of lectures designed primarily to give men engaged in the packing business a general survey of the entire industry and of company organization and operation will be given by well-known authorities in the industry. The appointment of a man technically familiar with the problems of industrial education is also recommended so that he may survey the educational possibilities and requirements of the industry.

Thus an immediate start will be made in the field of scientific research, practical research and education. It has wisely been thought best to proceed along unpretentious lines at first so that the growth may be natural and not forced. The packing industry is to be commended for its determination to support the plans laid by its forward-looking leaders. The development will be watched with a great deal of interest by all branches of the chemical and allied industries.

Renewed Demand for An International Economic Conference

IN EXPRESSING his desire for an international conference on economic and business matters, Judge GARY is only voicing the feelings of the business and industrial leaders of the country. Sentiment in favor of such a conference was very strong last spring, immediately following the Disarmament Conference in Washington. At that time the U. S. Chamber of Commerce made a special effort to get the Administration in Washington to take the leadership in calling such a conference, feeling that the apparent success of the Disarmament Conference augured well for a similar international gathering to deal with economic and industrial matters. The Administration, however, felt it undesirable either to invite an economic conference at Washington or to participate in one in Europe. Nevertheless many will still agree with Judge GARY in his hope that there will soon be held in Washington another international conference "for the full and frank discussion of all unsettled financial, commercial and industrial questions in which our people are interested, directly or indirectly, to be participated in by able, open-minded, well-disposed representatives from the different nations." The results of such a conference will be more effective and far reaching than the present long-range parleys among political representatives. We are inclined to the opinion that certain political matters will be soonest settled if business and financial representatives determine certain economic and industrial problems that now disturb the international prosperity.

Rules, Regulations And Esprit de Corps

ONE of the most foolish notions in business is that somebody can draw up a set of rules and then expect things to run themselves. EINSTEIN has pretty well destroyed the Absolute in philosophy, but the notion has not yet percolated into the heads of a vast number of men of affairs. A great general once gave his definition of the perfect officer as "a man who knows when to disobey orders." This holds true in industry.

A competent works manager of our acquaintance once was asked, after something had gone wrong, why he didn't post rules about the plant. He replied that his policy was to have as few rules as possible, but to see that they were enforced. Too many rules crowd one another out.

We know it is a great convenience to demand that "all letters be addressed to the company"; otherwise the person addressed may be absent or he may be the wrong person. But often it is an expensive rule, and defeats its own purpose. We have referred hitherto to the cost to a corporation involved in forbidding its salesmen to write personally to the superintendent or for him to reply personally—although it is just as easy to keep records of such letters as of those addressed nominally to the company. Here is an example of how it may work the wrong way. A correspondent writes:

> On one occasion during war time I was placed in charge of some new chemical equipment which had just been installed. None of the operating men, including the superintendent, his assistants or the engineers of the plant, were familiar with the operation of this particular piece of apparatus, for I asked them first. I finally asked permission to write to the head of the company manufacturing the apparatus, knowing the party in question personally. Permission was refused, it being against the rules, but they would do it for me. Though I asked repeatedly for any word of a reply, none was ever forthcoming and I was left to work out my own salvation. I am reasonably certain that had permission been given, I could have obtained the information desired in a few days. On another occasion with another concern where I was doing some experimental work in connection with catalysts, it occurred to me that I might be able to get some material I wanted to try out from a metallurgical concern. I had worked elsewhere with this superintendent, and had addressed a letter to him personally stating what I was after and asking for information. About ten days later the assistant manager of the firm I was with came out to the laboratory with a reply from the concern in question. It had not been answered by my friend personally, but had been turned over to someone else. This party had addressed a letter not to me, but to the firm I was with, advising them that someone in their employ had written personally for information, as though this was a crime, and, to show my offense, they attached my letter to theirs. The tone of the letter implied a rebuke to my company for permitting anyone in their employ to do such a thing.

When concerns get so big that individual members of their staff are forbidden to think for themselves or to do their best to make things move, it is time to decentralize into units that can so organize their operating forces as to achieve a real *esprit de corps*.

Cutting Capital Costs In Gas and Coke Manufacture

ONE of the greatest difficulties which the gas and coke-oven industries have faced during recent years is the very high investment cost per unit of product. It has been the ambition of all designing engineers in these fields to increase the unit capacity of installations without sacrifice of operating efficiency. The recent development of a new type coke oven described in this issue by JOSEPH BECKER seems to be an unusually successful step forward in this direction.

The seriousness of the situation in the gas business perhaps affords a more striking example of the difficulty which has been met than any which can be taken from the coke business. Previous to the war it was not uncommon for public utility companies to get money at 5 per cent and they could build the best plants then available for about $4 investment per thousand cubic feet of gas made per year. Thus the capital charge in the form of interest was only 20 cents per thousand, and other charges on capital thus invested were not excessive. In fact, it was not uncommon to find the total capital expense under 30 cents per thousand and the net operating cost was often almost nothing, for the return on byproducts frequently equaled material and labor charges for the entire process.

With the advance of money costs and the great increase in construction expenses of all sorts, the industry during the war period and since found a very different situation confronting it. In some cases money cost 7 or 8 per cent and construction costs advanced so much that $8 to $10 investment was necessary in coal-gas plants per thousand of annual output. With an investment of $10 and 8 per cent for interest alone, which are not by any means the maximum figures that were reached, the interest charge per thousand feet of gas made was obviously 80 cents. This was an almost prohibitive figure, and it is not strange that resort was had to other types of gas-making equipment in order to avoid these tremendous investments that would have been a millstone about the neck of a company for many years.

In the coke-oven business corresponding conditions prevailed, though perhaps not to such extremes. It is with great satisfaction, therefore, that one can look forward to great increase in output per oven. One example of this increase in output which is forecast

for the new type oven is given from the estimates for one of the plants now under construction. In this plant it is expected that thirty-seven ovens which cost little if any more than the earlier types will produce as much coke as fifty of the best previous type of oven. Thus at one stride the industry advances by 25 per cent. Needless to say, it is an advance that will be of great importance to users as well as to producers of this most important manufactured fuel—coke.

The Junquera Process Of Nitrate Recovery

THE U. S. consul at Iquique, Chile, contributes to a recent issue of *Commerce Reports* an account of a new process for extracting nitrate from caliche, invented by Señor BUENAVENTURA JUNQUERA. Official tests, we learn, "were witnessed by many men prominent in the nitrate industry," the result being that "there is a disposition to recognize that a new invention has been made which, when improved, may revolutionize the industry." The tacit admission that the new process is incomplete—that it needs improving—is no logical preliminary to the extravagant claims made, which include, *inter alia*, assurance that the adoption of the process will result in:

"1. An increase of ten to twenty fold in the nitrate riches of the republic, as caliches with nitrate content as low as 10 per cent can be worked profitably.

"2. Assurance to the government for many years of the collection of export taxes at the present rate without hurting the industry.

"3. Cheapening the cost of Chilean nitrate so much that the competition of artificial products will be postponed for many years."

The Chilean nitrate industry is noted for the number of its "experts." Let us examine the details of the test that convinced a group of these worthies that a new era of expansion and prosperity was at hand in consequence of Señor JUNQUERA'S invention. According to Consul BRETT, "the material is ground to pass through a ¼-in. mesh, and is then highly heated. It is placed in a battery of eight gyratory drums, each 6 ft. in diameter, and having its edge made of filter cloth. Water is forced into the center of the first drum and is driven through the material and out of the drum's edge, where it is caught and passed in rotation through all the drums. Leaving the eighth and last, it is saturated with nitrate and is allowed to cool and deposits its nitrate contents in settling tanks . . . Working with material of 12 per cent content of nitrate, the extraction was said to be total and the consumption of oil fuel was only 9½ kilos per ton, but it should be noted that this test was made with fresh water and that the various weak solutions were not worked out as they would have to be in actual practice."

The final paragraph indicates the absurdity of adopting an optimistic attitude in consequence of the "success" of an experiment such as this, for there is no reason, if dependable data were desired, why the inventor should not have used solutions of a nitrate content customary in practice. However, had he done so, the extraction would not have been "total"—by any means. It is easy to saturate water with nitrate, but it is a difficult matter to obtain saturation at a high temperature by the abstraction of nitrate from caliche and to leave a residue that contains less of value than it does after treatment in a Shanks maquina. The publication of figures indicating oil consumption during a test such as the one described is an indication of the absurdity of the claims made and given publicity by the American consul at Iquique, who obviously is unacquainted with the technique of nitrate recovery. Accounts such as this make a burlesque of the industry; they tend to discourage the entry of American inventive genius and equipment into a field that offers unusual opportunities for advancement and profit.

The Junquera system appears to lack all the essential features of a cheap and efficient process. That it can be "improved" in such a manner that the industry may be "revolutionized" will be doubted by those who are familiar with the operation and scope of centrifugals, with the handling of high-grade nitrate liquors and the economic removal, by selective solution, of a soluble salt from earthy material.

Electric Furnace In the Steel Industry

ELSEWHERE we print a brief address made before the American Iron and Steel Institute by Dr. JOHN A. MATHEWS on "The Present Status of the Electric Furnace in Refining Iron and Steel." Metallurgical engineers particularly will be interested in what he has to say, because he is one of their number who has achieved conspicuous success in an executive capacity, or, as he more aptly puts it, a siderologist turned considerologist. Furthermore, he knows whereof he speaks, for he was one of the officiating doctors at the birth of electric steel in America.

In the intervening 16 years he has had ample opportunity to study the relative merits of open-hearth, crucible and electric steel. If memory serves right, he has always been a very enthusiastic advocate of the electric furnace, but has never been willing to admit that the crucible process would be supplanted in the production of superfine steel for small tools. Even recognizing the fact that the crucible pours out only what was put in, an electric furnace will pour out nothing but mediocre stuff unless great care and keen intelligence are put into it, along with so many kilowatts. So the relative quality of the two processes is truly relative—bad steel has been produced from both; most excellent steel has been produced in quantity from both—each heat must be judged on its own merits. By and large, Dr. MATHEWS still appears to favor the crucible, quoting his own words, written several years ago:

"It is seldom that a process is discovered that cannot be improved upon. Crucible steel is an exception to this rule. This earliest process makes the best steel and has never been surpassed."

Much more interesting is the fact that he is one of the few executives in the American steel industry who have a lively appreciation of what quality in steel means, and of the responsibility of the industry in providing metal considerably better than "just good enough to get by." Consequently his words have a great deal of significance as an appraisal of the trend in the steel-consuming industries (rather than the steel-producing), and as a prediction on the future of fine steels in America:

"When users acquire a full appreciation of what clean sound steel means in terms of national efficiency, safety and economy, we shall see more rapid growth [in the use of electric furnaces] than has as yet been seen. Its usefulness to engineering and industry has just begun."

Readers' Views and Comments

Growing Appreciation of the Value of Chemical Warfare

To the Editor of Chemical & Metallurgical Engineering

SIR:—Can it be possible that the country is beginning to regret its hasty action in so readily entering into an agreement to abolish chemical warfare? Only within the last week a Chicago newspaper twice raised the question of chemical warfare. Nor was it mentioned—as newspapers were wont to mention it—as a weapon of war to be abhorred; brutal and inhumane. Chemical warfare was urged, editorially, as a bulwark against the perils of an Asiatic invasion. A lengthy interview with ex-General von Ludendorf concludes with the forecast that the next war will be fought with the power of science rather than with multitudes of men.

With such slight encouragement shown and emanating as it does from the press, it seems all the more desirable to keep up the good work of educating the people to see the value of chemistry in warfare. Our Chemical Warfare Service is doing a wise piece of work in devoting part of its energies to the study of fumigation. The results from this work should be pushed to broad publicity.

Irrespective of what may be said against popularizing science, it must be conceded that our Chemical Warfare Service must be popularized—to use a timeworn expression, it must be "sold" to the public in general and to the personnel at Washington in particular—if we are to maintain that branch of the army in even a state of defensive preparedness. FLOYD K. THAYER.

The Abbott Laboratories,
Chicago, Ill.

Who Financed the German Economic War?

To the Editor of Chemical & Metallurgical Engineering

SIR:—The first article on "European Conditions as I Saw Them" printed in the Oct. 18 issue of *Chem. & Met.* has raised the question: Who financed the German economic war? This very logical question can be answered by elucidating somewhat the statement that those who engineered this war, being good German psychologists, foresaw to a certainty that ample finances lay dormant first in the productive power of the German masses and second in the get-rich-quick mentality of the foreign dupes so well defined by the American expression "suckers."

That the productive capacity of the German masses has yielded vast amounts of munitions will become evident after reading the other articles (nine in all) which complete my series. They will prove that the German employees got as wages and salaries only a small fraction of what they ought to have received, were they paid the due reward for the intrinsic value of their work. This was an easy task, considering that the German masses could readily be brought to the point of believing that they were acting as soldiers and that they kept on fighting under the continuous propaganda of hatred against the makers of the Versailles treaty. They and their families were not left to suffer physical hunger, because the German Government acted as a fatherly quartermaster by facilitating their getting the strictly needed food with their minimum-for-existence pay. Similarly with their transportation and rent costs. As for the remainder of their needs and wants—well, good soldiers must not play at living *schieberisch* (like profiteers) while in active service.

The foreign dupes have contributed vast amounts of real money in exchange for German-printed banknotes. This was an indirect levy on all the world and was easily accepted because it was cloaked in the form of a get-rich-quick inducement for speculation in German paper marks. Few are the foreign bankers who did not accommodate eager clients with this made-to-order so-called German money. It is not for me to produce statistics as to what extent America, England, Holland, Switzerland, Spain and all the other countries with par money have answered the call for this indirect levy, but it is already public knowledge that America alone has thus contributed nearly one billion dollars—i.e., about twice as much as the total amount in money which Germany has thus far paid to the Allies. I may mention here that very reliable persons have told me that along the boundary between Germany and Holland Germans sell in the public markets basketfuls of German paper marks for foreign currency.

What was still needed to complete the total of the required finances was provided from the assets which the German Government still had at the close of the war. This was the first source of supply to be exhausted and was rapidly followed by sharp drops in the two other sources of supply, with the result, as pointed out in the above-mentioned article, that Germany has lost her economic war.

The productive capacity of the German working masses, which has been only sparingly paid for, the vast amounts of good foreign money obtained in exchange for their printed paper marks and the amounts contributed by the German Government to enable the working masses to subsist on their minimum-for-existence wages provided the sum total of the finances used in carrying on their disastrous economic war. J. S. NEGRU.

New York City.

Electric Welding by Alternating Current

To the Editor of Chemical & Metallurgical Engineering

SIR:—We notice on page 712 of your issue of Oct. 4 that you give space to note on "Electric Welding by Alternating Current," as being a new thing. It is new, but you don't have to go to Stockholm to find such a system.

This company holds exclusive license under patents for such an alternating current transformer welding system, the patents being granted June 3, 1919, applied for in 1917, and the development made from 1912 to 1916.

A technical description of it was given before the American Institute of Electrical Engineers, White Sulphur Springs meeting, June 29, 1920.

ELECTRIC ARC CUTTING & WELDING CO.,

Newark, N. J. BY C. J. HOLSLAG.

American Iron and Steel Institute

Judge Gary Heads Notable List of Speakers at Semi-Annual Meeting—Technical Sessions Hear Papers on Fuels, Furnace Design, Fluorspar, Steel-Making Equipment and Fine Steel

Editorial Staff Report

ABOUT 900 steel makers and men interested in steel making assembled last Friday at the American Iron and Steel Institute's semi-annual meeting, to hear what Judge Gary, chairman of the U. S. Steel Corporation, had to say about the business outlook, and to swap views on coal, recent shows, the Kaiser's autobiography, and the way Tom Brown plays the nineteenth hole at Gadzooks. Perhaps some mention was also made of the price of pig. A hopeful sign is that the Judge made one of his few references to technology, when he remarked that we are now making steel of better quality than ever before. It appeared, also, that the listeners to the prepared papers were rather more numerous than formerly—as is fitting. No report of the committee studying the 12-hour day was presented, since it has not yet been able to collect the necessary data on its prevalence.

Judge Gary's Address

The president's address was, as usual, confined to carefully chosen generalities on the business situation, both in its international aspect and as this is reflected in the iron trade. Judge Gary can see no quick relief from present high prices, since he believes that the price of commodities is made up of 85 per cent labor cost and there is no apparent possibility of reducing wage rates, except in isolated cases. The only way he sees to get away from the vicious cycle of rising prices is to suppress all conspiracies to control production, trade or labor; to refrain scrupulously from interfering with the natural law of supply and demand; and to insist upon unprejudiced and adequate publicity about business conditions and practices. Failure to observe these conditions is responsible for the only obstacles to unbounded success for the American steel industry, since we have an extraordinary amount of raw materials, transportation facilities, skillful personnel and diversified demand. Mr. Gary is opposed to cancellation of the foreign debt, likening such to "forced charity." He thinks that an international conference on economic conditions, if held in Washington and attended by such high-minded representatives as was the Arms Conference, would be of great value toward re-establishing commercial peace.

Fuel and Fuel Economy the Theme of Technical Sessions

Nine excellent technical papers were read. With two or three exceptions they referred to production, storage and economical consumption of various types of fuel. Some of those papers are without the province of *Chemical & Metallurgical Engineering*.

Some remarks made by H. Foster Bain, director of the Bureau of Mines, may help the casual reader to realize the difficulties of stabilizing the coal industry. In introducing his paper on "Modern Methods of Mining Coal," he said that business and humanitarian impulses in the coal industry were apparently quite divergent. Thus the best results may be had if a coal-mining area is equipped to work intensively, continuously and at such a rate that the coal will be exhausted in 25 years. Each such development requires the building of a town to house the workers; yet in 25 years a community has barely time to take root.

"Storage of Bituminous Coal" was another paper (by Messrs. Stoek and Freeman) which has incidental interest. Coal storage costs not less than 25 cents a ton; on the other hand, excess mining expense in slack times amounts to twice that much. Deterioration in the coal occurs at the surface only, and is therefore quite negligible in large piles. Spontaneous combustion occurs almost exclusively in fine coals, those with high FeS_2 content or those stored over timber or rubbish. Fires can be extinguished only by digging out the burning coal.

Power Plant Economies

It is seldom realized that the total power used in a steel mill may easily cost 5 per cent of the sales value of the finished steel, even with good utilization of by-products. This figure may be reduced by electrification —elimination of steam engines and boilers and installation of electrical generators driven by gas engines, and motor drives at all points, as pointed out by E. F. Entwisle of the Bethlehem Steel Co., in a paper entitled "Economic Importance of the Power Plant." Few plants could not reduce their total power costs and show a good return on the necessary expenditures—failure to proceed along these lines can be excused only where the same amount of money invested in other departments would show a greater return.

Efficiency of Heating Furnaces

W. P. Chandler, Jr., of the Carnegie Steel Co., presented a paper on "Heating Furnaces for Blooms, Slabs and Billets" in which he gave heat balances for two large furnaces on such work, one continuous and the other non-continuous. The latter was built like an open-hearth furnace, fired through ports at either end, with air and producer gas preheated by underground regenerator checkerwork. Its hearth was 18x35 ft., with a burned-in silica bottom. Cold blooms varying from 5 to 10 in. square were charged through six doors, and heated to rolling temperature, 2,100 deg. F. As the furnace was unloaded, it was progressively refilled with cold material. Two furnaces are necessary to feed one rolling train. Thermal efficiencies—heat absorbed by steel divided by total heat in gas supplied—varied from 36.5 to 41 per cent, the latter occurring when heating steel at the slowest rate—viz., 32,900 lb. per hour.

Continuous recuperative furnaces showed better efficiencies. The one studied had a sloping hearth 25 ft. long and 32 ft. wide. Billets were charged and discharged endwise through small side doors, and rest on cast iron skids, not water cooled, or on a magnesite-brick bottom at the firing end. The roof is a series of flat arches. It is cooled from above by air for combustion on its way to the recuperator, after passing which it goes through passages under the hearth and then to a series of fifteen gas burners, thus acquiring a total

superheat of 325 deg. F. The recuperator consists of a series of vertical cast-iron pipes through which hot waste gases (at 1,300 deg. F.) pass on the way to the stack. Air for combustion bathes the outside of the pipes. Thermal efficiencies varied from 47 to 57 per cent, being greatest when heating 2½ in. square billets at the highest rate—66,000 lb. per hour.

A similar furnace, wherein the recuperator was built of brick tiling, gave efficiencies of 58 to 63 per cent. The increase was principally due to lower stack losses—i.e., the air for combustion was preheated 25 deg. higher, and less of it was required for correct combustion.

Various recommendations can be made, looking toward an even more economical furnace of the continuous type. Roofs should be flat, without water cooling, and placed rather low over the steel. A roof recuperator should be installed only when the roof would melt if adequately insulated. The hearth should be sloped downward toward the discharge end, and have solid cast-iron skids built in. Numerous burners will give more uniform heat distribution; each should have independent adjustments and control. Gas and air pressures at the burners should be automatically registered, and each furnace should have an accurate gas meter. Slots and swinging doors for charging or discharging the steel should be avoided on account of large leakages of cold air which always takes place. Have small doors on the sides. Metal recuperators are doubtless best; they have higher heat conductivity than firebrick, and may be made tighter. If the recuperator is properly designed, it will make it unnecessary to install a waste-heat boiler. Insulate wherever the brick will stand it. Avoid water-cooled devices.

W. P. Chapman, in the discussion, showed some photographs of special recuperative furnaces for glass making, which gave a much higher superheat and required much less air for combustion. This was done by using recuperators made of special thin-walled tiles, having small straight passages for air travel. Leakage was minimized by special joint construction and so arranging the fans that pressures on the waste gas and air side of recuperator passages are substantially equal.

Professor Trinks, of Carnegie Institute of Technology, also pointed out that the efficiency of continuous furnaces was a maximum when heating about 30 lb. of steel per sq.ft. of surface per hour. Very great heat losses are due to leakage, not only in the recuperator but by cold outside air leaking into the passageways. Unquestionably a continuous furnace should be used wherever permitted by the uniformity of shape and size of material to be heated and steady operation throughout the rest of the mill.

Liquid Fuel

A treatise on the "Use of Liquid Fuel in Metallurgical Furnaces" was prepared by R. C. Helm, of the American Steel & Wire Co. Fuel oil from 30 to 12 deg. Bé. has been used for this purpose. Flash point should be over 150 deg. F. to reduce fire hazard. Sulphur is limited to 0.75 for open-hearth melting, although after the bath is covered with slag high-sulphur oils can be used to complete the work. This involves a duplicate installation, which is not relished. High-sulphur oils will also discolor sheet brass during annealing. Solids, which clog the pipes and nozzles, are carefully removed by strainers, placed in the pipe lines in duplicate.

Oil nozzles atomize the fuel by a spray of dry steam or air at high pressure; a number of such designs were illustrated. Mechanical atomization so common in boiler practice is almost unknown, possibly because the latter throws a flaring conical flame rather than the long torch effect desired in most furnaces.

Coke-oven tar is used wherever it may be had cheaply. It is heated to about 160 deg. F., when it can be pumped about easily. Three-inch mains, steam jacketed, deliver the oil to the furnaces; sometimes a 50 per cent excess must be circulated. Special nozzles (steam atomizers) are also required. While the equipment necessary to handle tars and oils of low gravity seems quite complicated, the very low price of the fuel furnishes an attractive return on the investment.

Open-Hearth Design

One of the most notable papers of the session was on "The Thermal Efficiency and Heat Balance of an Open-Hearth Furnace," by Messrs. Kinney and McDermott, of the Illinois Steel Co., notable because it shows how thermal investigations have pointed the way in designing more efficient furnaces. We hope to give adequate space to present the details of this study in a later issue.

Various speakers urged that the Iron and Steel Institute appoint a committee to recommend standard methods for thermal studies. Apparently a great amount of this sort of work is being done, but it is not readily comparable between plants, because of variations in experimental procedure and methods of calculation. Much work ought also be done on specific heat and conductivity of refractories, metal, and gases at high temperatures.

Electric Furnaces

Dr. Mathews' important paper on "Present Status of the Electric Furnace in Refining Iron and Steel" is reprinted in full on page 872 of this issue.

Automobile Steels

A paper entitled "The Steel Requirements of the Automotive Industry" was presented by Henry Chandler, of C. H. Wills & Co. He emphasized the fact that automobile steels are bought on physical properties; even though chemical analysis is often specified, it is done only because the purchaser knows that a well-made steel of that composition will satisfy his other requirements. Tensile test is chiefly relied upon. While it by no means duplicates the service conditions (the ultimate test), when correlated with other tests and with experience it furnishes a sound basis for estimating quality. Mr. Chandler places considerable faith in the "merit number" derived from a tensile test.[1] Brinell or scleroscope tests are next in importance, giving information on machinability and the efficacy of the heat-treatment. The impact test is often used, and its chief usefulness it to check the merit number derived from the tensile test. Sometimes the microscopic constitution of the steel is so different from the expected that the above-mentioned tests give quite misleading indications—they must therefore all be interpreted in the light of full and complete information.

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[1] "Quality in metal is equal to $\frac{\textit{work done}}{\textit{metal affected}}$, which is proportional to $\frac{\textit{mean breaking strength} \times \textit{elongation}}{\textit{constant} - \textit{reduction in area}}$, where the constant varies as the type of fracture.

Ninth National Convention of Society of Industrial Engineers

The Society Devoted Its Attention to the Significant and Timely Topic of the Relation of Economics and Business—An Abstract of the Most Significant Speeches Reflects the Progress Being Made Along These Lines

EDITORIAL STAFF REPORT

PLEASE consider this a kind of official introduction to the Society of Industrial Engineers. The organization of this society was significant, and its work continues to be significant. It is indicative of the increasing attention which is being devoted to the problems of scientific management in all of its phases. Chemical industries have suffered and still do suffer from a lack of contact with the principles of scientific management. This statement does not mean, of course, that many chemical companies are not well managed. That would be absurd, but if they are well managed, it is probably due to a rather empirical development than to a careful study of management principles as such. It is therefore high time that the attention of these industries should be turned to a group which is devoting its energy to the study of these principles and to the development of new ones.

PRESENT STATUS OF ECONOMICS IN BUSINESS

The meeting in New York last week took for its text the economics of industry and intended to develop such fundamental economic principles as were necessary to maintain maximum production with a minimum effort, waste and cost. President Joseph W. Roe, head of the department of industrial engineering at New York University, gave the keynote speech. There is, he remarked, a close analogy between the attitude of the manager of an industrial plant of today toward economics and the attitude of the plant manager of 50 years ago toward the study of science. The attitude runs its course from an amused tolerance to a distinct distrust, with enough significant exceptions who take a serious interest in the subject and who make it worth while to study the exceptions. Fifty years ago these exceptions, the men who pinned their faith on the scientifically trained engineer, soon made it apparent that industrial waste and mechanical inefficiency which were then so universal could not be tolerated. It is now a paramount question to eliminate social waste in industry. Nearly all waste in industry is now due either to bad management or social causes. It is of course legitimate to point out that good business men are often ignorant of economics, but so too were the good practical engineers without scientific training a generation and a half ago. With the present complexity of industry, the economist becomes essential. He sees forces in perspective which the individual manager can but vaguely feel.

Let us take as an example a single economic law, the law of diminishing returns, and study industry to see in what ways this law may operate. The first example has been multiplied so many times in the last 2 years that it is almost a redundancy to mention it. Overproduction is inevitably and invariably a result of a disregard of this economic law. Another variation of this law is the possibility of an economic limit to the size of a business. One conspicuous example will develop the idea which lies behind this. Holmes of the Waterbury Valley is a name to conjure by in the brass industry. During the middle of the last century he started five successful enterprises which are still in existence. He believed that a thousand employees was the right size of any individual unit in the brass industry, and when he reached a thousand employees he started over again. Therefore the continued success of these five enterprises is noteworthy and makes very pertinent the question, Can we overdo size?

We must bring industry and economics together, concluded President Roe. First, let the labor leaders and industrial men read economic history and study its cycles. Let there be more readable economic books and sound economics taught, not only in colleges but in schools. Business men should be taught to use the present statistical sources and through their trade associations to study economic problems, including such things as the sources, quantities and prices of prime raw materials, not only in their own industry but in other industries.

ECONOMICS PART IN FORMING BUSINESS POLICY

Another keynote speech was made by J. H. Pardee, president of the J. G. White Management Corporation. From his wide experience he picked out the functions of economics in forming a policy of business administration. Business men today are gamblers, most of them, he said, largely because they do not study the fundamentals of economics and their application to their own business. There was in his opinion one great need in economics at the present time, and that was standards throughout the science. Mr. Pardee pointed out that chemistry, physics and astronomy made little advance until standards of measurement were adopted, and finally developed the very significant analogy that very little progress was made by the Interstate Commerce Commission on railroad problems until it had thoroughly standardized procedure, nomenclature and measurements. It was notable, he pointed out, that such problems as tariff, taxation, etc., find astute business men on opposite sides. This, he felt, was due largely to the fact that the definitions in this field did not define and that there is a distinct lack of adequate standards. With proper standards the many problems which now confound the business man would undoubtedly be ironed out. He would be able better to understand the law of supply and demand in relation to his own business. He would see that selling price and cost of production were interrelated. He would understand the fallacy of a fixed overhead and more than 10 per cent of the manufacturing establishments (the present ratio) would see the vital necessity of adopting cost accounting systems.

The Employer-Employee Relation

Two questions which primarily involve the employer-employee relations were discussed ably and at some length at one of the sessions. The discussion took the

form of answers to two questions. First, how can we reduce production costs, and, second, what keeps the workers contented? Each of these questions was discussed, first through a paper designed to represent the employer's point of view, and then with a paper presenting that of the employee. James A. Faust, of New York City, pointed out the significant fact that chief executives are usually somewhat unbalanced. This is not at all strange, for, of course, a chief executive develops through one of the individual departments, either sales or cost or production, and it is therefore quite understandable that his department of the work would be more emphasized because he was more familiar with it when he became chief executive. Mr. Faust claimed that the chief executive was the chief factor in cost reduction. Charles M. Schwab once said that he had no high-priced executives in his company, but he had the best paid executives in the country. The way he attained this peculiar situation was by paying them a bonus; for any man, he said, can produce pig iron for, let us say, $1 a ton, and that was what he was paid his salary for, but if he produced pig iron at 95 cents a ton, then he would receive 5 per cent of the net saving that he had made, and so on. If the chief executive cannot pass on an enthusiasm and a faith in the organization down to the lowest workman in the plant, that organization will fall short of its highest efficiency by just so much.

The Big Problem of Co-operation

From the worker's standpoint Mr. Geiger of the Keratol Co. pointed out that costs could be reduced by using the workman's time to better advantage. The worker has three things to give a company—time, skill and co-operation. Of these time has up to the present received by far the greatest attention. Time charts, man charts, etc., are becoming better and better known, but it must be remembered also that unused skill is as expensive as unused time, and if for reasons of poor co-operation a workman is not stimulated to use his best skill and thought for the company, then that company is not using that workman to either its or his best advantage. Co-operation is that easiest and hardest thing to obtain, and it is extremely necessary to the efficient use of the worker's energy. A suspicious worker is not a good co-operator, and a worker will become suspicious if he feels that for some reason or other he is not getting his just due. Wages alone, be they high as the sky, and fancy cafeterias do not make a good place in which to work.

The second question, how to keep the worker contented, was answered from the standpoint of management by Charles Cheney of the Cheney Brothers Silk Manufacturing Co., South Manchester, Conn. He pointed out that it was necessary to go back to fundamentals before this problem could properly be studied. What is contentment? Above all, it should not be sedative, and it should not stifle the creative impulse which exists in every man, be he workman or executive. The welfare worker is looked on with suspicion, because welfare work has been undertaken so often in a narrow spirit, demanding a plastic submission. Does it pay to do welfare work? He hoped so, but he felt the proof was lacking. Another question, the answer to which was also more or less indefinite but which he also hoped was true, was, Does it pay to be honest? The sore, aggrieved worker is a menace, and he must be eliminated, not by being kicked out, but by being taken into the confidence of the organization management, by being made an associate. Then, treated as an associate, he must receive his due.

What is his due? Again, we must get down to fundamentals. Compensation should vary with the results received, but should vary with the results obtained by the individual and not the results obtained by the business. The amount of compensation should first of all insure a margin of safety above decent living. Such extra compensation as is in order should be based on individual efforts, should be large enough to strive for, should be paid soon enough to make the worker realize just what effort is necessary to accomplish that result and should be paid on a system simple enough to be easily comprehended. It is not generally known that such a system of compensation has been applied as well to clerical help as to mere manual or machine labor. In addition to such a basis of compensation based on efficiency, Mr. Cheney recommended a credit rating plan, adding a bonus for good citizenship, for marriage, for service, as well as for efficiency. In other words, the value of a man to a firm will vary in respect to these things, and therefore it is reasonable to vary his compensation on that basis too.

Profit sharing, as it is practiced at the present time, is not logical. It is a present and nothing more. The statement that labor makes profit he believed to be inaccurate, for he felt that labor had almost no connection with the profits of a business. Labor could be faithful, could give his own best energy and yet the business might fail, due entirely to poor purchasing, poor sales policy, economic conditions, strenuous competition, poor advertising or any number of other items over which the individual worker has no control. The fact that he has common interest with the firm does not make him a partner in the firm. Furthermore, profit sharing has not worked out well in practice. The advantages gained at first are soon lost, and the profit-sharing bonus is expected as regularly and counted on as definitely as ordinary wages. Many firms have found it extremely difficult to discontinue profit sharing in bad years. Furthermore, Mr. Cheney felt that in general the investing of the employee's money in the business was not wise and somewhat dangerous.

The worker should be dealt with on a basis of justice, plus consideration, sympathy and human interest. It must be reciprocal, and the method of accomplishing this is by personal work rather than by any cut and dried system. Labor does not want to lead, but is willing to be led if kindly led. His thoughts must be expressed somewhat and should be expressed for the benefit of the firm, and his aspirations must be considered and made to coincide as closely as possible with the interests of the firm itself. When this identity exists, the state of that corporation will be healthy.

Partly in reply and partly in extension of the remarks of Mr. Cheney, O. A. Prebble, who has been an officer in the American Federation of Labor and has been connected with labor problems for a long time, presented what might be considered labor's views. With Mr. Cheney, he felt that labor wanted justice more than anything else. He did not want presents or patronage or even consideration—but justice.

Economics and Production

From the standpoint of the engineer the most immediately appealing subject on the program was that covered by Ernest F. Du Brul, general manager of the

National Machine Tool Builders' Association, "The Economic Aspect of Production." The problems of production and the vocabulary of production are familiar to the engineer and therefore hear what he has to say!

THE ENGINEER'S CONTACT WITH ECONOMICS

The engineer thinks of the fabrication of physical goods when production is mentioned, but there is danger in this point of view. The danger is that he will and does consider that when goods are fabricated, value is created. True, money has been expended in fabrication, but there is no value until a market has been obtained. In other words, production of utility, which is the thing of value, must not be dissociated from distribution and financing, else we begin to have the unbalanced view that: "The producer gets too little out of what the user finally pays," and "Labor produces all wealth." Accordingly they begin to think that simply by fabricating or growing something, they are entitled to demand other goods and services in return for theirs.

Another point in which the fabrication man's logic has slipped a distinct cog is in adhering to the fallacy, "The more the output of the plant the lower the cost and the greater the profit." This does not follow and many an engineer has urged greater production when it resulted ultimately in increased cost, and even when costs were lower a market was often not assured. Even so it has been in many industries. The rubber tire industry suffers today from a large overhead which it must carry. The market was estimated to be nearly double its actual extent.

Different businesses will require widely different policies. Standardization of their patterns would be fatal where standardization of a make of automobile is vital. An expert aviator may know nothing of the physics and thermodynamics of engines. Yet both the expert in construction and design and the aviator are essential to the progress of aviation. So with the economist and the business man. The one must discover and the other apply economic laws to the business machine. More, more and still more economics will be essential to proper and effective progress.

OTHER CONVENTION ACTIVITIES

In abstracts of these few keynote speeches we have reflected the outstanding spirit of the meeting. There were many other papers presented, prominent among which were "The Budget and the Financial Forecast," by A. J. Lutterbach, controller of the Palmolive Co., and "The Necessity of Waste Elimination to the Economic Structure," by Robert B. Wolf.

There were group meetings on a variety of topics: The Economic Background of the Executive; The Measurement of Management; The Reduction of Sales Costs; Is There a More Scientific Method of Selecting People for Jobs? The topics were interesting, but in general the discussion fell short of the high plane of the addresses. The discussion was not animated in those groups attended and the matter brought out was usually nothing more than casual. With that reservation, however, the meeting was thoughtful, timely and stimulating. Give the society your attention. We believe it will merit it.

Prof. J. W. Roe was re-elected president of the society and announced that the next convention would probably be held in Buffalo during April of next year. No subject has been chosen as yet for the meeting.

Status of Italian Artificial Silk Industry

The Italian artificial silk industry has attained a considerable development as regards capital invested, labor employed, raw materials and actual production, says *Commerce Reports*, Sept. 25, 1922. The industry is a comparatively new one, being unkown in the world's market for only 30 years and in Italy for about 15. All four known processes are used—nitrocellulose, cuprammonium, cellulose acetate and viscose.

AMOUNT OF CAPITAL AND LABOR INVOLVED

The present amount of capital involved is about 420,000,000 lire (approximately $21,000,000 at current rate), and by the end of 1923 it is estimated that the amount will be fully double that figure. Twelve thousand laborers are now employed, and by the close of 1923 it is estimated that the number will be about 20,000. Some of the raw materials used—i.e., soda, carbon bisulphide and sulphuric acid—are produced by native industries, and it is hoped that after a time the wood pulp may be also, though at present it is imported principally from Scandinavia. Considerable quantities of cloth, hosiery and knitted goods are being manufactured from the fiber.

At present there are five large factories in Italy—located at Pavia, Padua, Venaria Reale and Cesano Maderno, which produce in all 24,250 lb. of artificial silk per day. These figures are furnished by the Associazione Nazionale Seta Artificiale. It is estimated that, with the possible increase in the production of the old plants and with the two new large factories in the course of construction at Rome and Naples, the present production will be more than doubled.

IMPORTATION DESPITE LARGE DOMESTIC PRODUCTION

The rapid increase in the uses and consumption of artificial silk justifies the great increase in production, says the *Bollettino di Notizie Commerciali*. At present the factories do not meet the national demand, as they have a considerable export trade. Consequently there is quite an import trade also. The imports come at present from countries of high exchange conditions—which are also the greatest and best producers and exporters—as the German production is insufficient to meet the needs of its own market at home.

The export trade is constantly increasing. This is doubtless caused not only by the quality of the Italian product, but also by the exchange situation, as the trade is directed almost exclusively to countries where money has depreciated very little, if any. The latter element is, of course, of transitory character and a change in currency conditions or the revival of competition by a country with lower exchange than Italy (for example, Germany) might alter the situation greatly.

Study of Electric Furnace Refractories

As it is hoped to develop refractories for electric furnaces, it is desirable to have a method and apparatus for measuring their conductivity at advanced temperatures, states the Bureau of Mines. Moreover, data in regard to the conductivity of existing refractories at temperatures above 1,400 deg. C. are meager. It is proposed by the bureau to study the leakage factor through refractories. The method of attack has been worked out and the furnace designed, the material for which is arriving at the bureau's ceramic experiment station at Columbus, Ohio.

The Present Status of the Electric Furnace in Refining Iron and Steel*

Flexibility of Furnace and Quality of Output Have Established the Position of the Electric Furnace—As Consumers Realize the Economy of Using Clean, Sound Steel, They Demand an Increasing Tonnage of Electric Steel

By John A. Mathews
President, Crucible Steel Co. of America

IT SEEMS to have been generally overlooked by the steel trade that this year, 1922, marks the tercentenary of iron making in the Western Hemisphere. In 1622 the first iron was made at Falling Creek, Va., and in the same year the plant was destroyed and the workmen massacred by the Indians. It is a far cry from charcoal hearths and forges to the consideration of the electric furnace—the latest development in steelmaking processes.

Optimistic Predictions of Inventors

The earliest literature of electric melting of iron and steel dates back but a score of years and was provided by the inventors of various furnace types. It is characterized by the enthusiastic optimism of the inventor, and on that account may not have been considered very seriously by conservative, practical steel men. Their confidence in electric furnaces may not have been greatly increased during the next few years by the writings (including my own) of those who made the earliest installations. They may have felt that there was something of the child-with-a-new-toy air about them, and that both inventors and early users were overstating the case and that time and further experience might change matters. The war needs stirred some of the doubting Thomases to action and furnaces were installed in great numbers, particularly in the years 1917 and 1918. So rapid was the introduction of electric furnaces at this time that I felt constrained to utter a word of caution in a previous paper to this Institute[1] when I said: "We will pass through a period of reaction and dissatisfaction with electric products while many of the new furnaces are in the experimental stage."

This opinion was based upon the fear that furnaces could be built faster than skilled operators could be trained. I now feel that my fears were justified by the experiences of the war period, for much electric furnace product was not what it should have been, and possibly not as good as much of the open-hearth product produced during the same period. I have always discouraged the idea that the electric furnace was a foolproof and automatic process for making superior steel by those unskilled in steel making.

Importance of the Method at Present

I believe now that the period of disaffection is past and that the 16 years of experience since the first electric furnace was installed in America, at the Halcomb Steel Co., have been sufficient to afford a sounder basis of judgment than may have been afforded by the earlier literature already mentioned. There are now nearly 1,000 electric furnaces in America and Europe, not quite half of them in the United States and Canada. Constant interest in these developments from the beginning leads me to feel that the pioneer writers were not overenthusiastic and that their claims and predictions have, in general, been fulfilled.

It will surprise many of you to know that Italy has about 180 electric furnaces for steel melting, and that 27 of them are from 15 to 25 tons capacity, and in 1921 her tonnage of electric steel was second only to that of the United States and reached a new high mark for that country. The annual productive capacity there is about 1,000,000 tons, and Dr. Giolitti recently told me that some of these furnaces were operating at unusually high speed and with great economy of electrode consumption, as low as 6¼ lb. per ton for cold melting. For installed capacity, Italy ranks ahead of Germany, England and France, and second only to the United States.

The rapidity with which electric furnaces have been installed within the last decade all over the world calls for some analysis as to cause. After 10 or 12 years of invention and pioneering there were about 125 furnaces in the world in 1912. At this time Germany led with nearly one-third of the total number. Today, as nearly as may be estimated, there are 1,000 furnaces, 388 of them being in the United States according to the *Iron Age* figures for Jan. 1, 1922. Accurate statistics have been extremely difficult to secure during late years, but according to Dr. Richard Amberg[2] there are 65 furnaces in Germany engaged in the manufacture of ingots, with a yearly productive capacity of 430,000 tons, and an unknown number of furnaces making steel castings, with a capacity estimated at 300,000 tons per annum. I think we may estimate the total number of electric furnaces in Germany as about 100 to 110.

Flexibility of the Electric Furnace

The reasons for the world-wide expansion of electric steel making are three:

(1) Cheapening of wholesale power rates, due to hydro-electric and improved steam plant developments. Thus it is now commercial to use electricity for melting, whereas the original promoters of arc furnaces felt that their use would be of necessity confined to refining of metal premelted by the older processes.

(2) The extreme flexibility and adaptability of electric furnaces to a wide range of uses. It has been shown by experience that they may be successfully used for melting cold charges or refining liquid charges, for making ingots or castings, and for melting ferro-alloys. They may be used alone, or in conjunction with the bessemer or open-hearth, or both. They may be operated acid or basic. They may be used in conjunction with the blast furnace or cupola for making gray-iron, malleable and semi-steel castings. For foundry use particularly the small units are advantageous for making frequent small heats of steel or iron castings.

*Paper read before the American Iron and Steel Institute at New York, Oct. 27, 1922.

[1] "The Electric Furnace in Steel Manufacture," Yearbook American Iron and Steel Institute, 1916, p. 73 (May, 1916).

[2] "Electric Furnaces in the Iron and Steel Industry," *Helios*, vol. 28, p. 169, for April, 1922.

The most popular size of electric furnace in this country is of 6 gross tons capacity, but furnaces from ½ ton to 40 tons capacity have proved equally successful. In furnaces of 6 tons or a little larger hand charging is general, but in the larger sizes either mechanical charging of cold materials or the use of hot metal charges is usual. Duplexing of open-hearth steel is practiced in many of the larger units, while triplexing is done at the great installation at the Illinois Steel Co. as described at the Institute a few years ago by T. W. Robinson.[3]

All of the manifold methods of operation are possible with the use of arc furnaces, which are by far the most frequently used here and abroad. Of the different types of arc furnaces in the United States nearly one-half are of the Heroult type and considerably more than one-half of the productive capacity is represented by them.

The electric furnace has small possibilities in this country for the manufacture of pig iron from the ore, but during the war period several furnaces were used to make so-called synthetic pig iron from turnings and borings and other light scrap in the United States, Canada and France. In Sweden, Norway and Italy, where metallurgical fuel is very dear and electricity is cheap, electric smelting of ores is an established industry. The world's production for 1921 is placed at 377,900 tons, and most of you will recall that the year 1921 was not a good year for high records.

Quality of Product

(3) Quality of products. A new process to succeed must be cheaper in operation or produce a better quality. The cost of electric steel is rarely lower than open-hearth and never lower than bessemer, and therefore its success is presumably due to its producing a generally superior product. Of course there are especially favored localities or peculiar market conditions which warrant the installation of small electric furnaces where open-hearth and bessemer installations would be out of the question. In the same localities and markets electric furnaces do operate successfully alongside of large-tonnage plants, and under such conditions quality must be the principal reason for success rather than low cost.

It is quite obvious that this country has not installed 1,500,000 tons of productive capacity to compete with the present crucible capacity of one-tenth that volume. In an address several years ago I said: "It is seldom that a process is discovered that cannot be improved upon. Crucible steel is an exception to this rule. This earliest process makes the best steel and has never been surpassed." The superior lasting qualities of German guns was often ascribed to the use of molybdenum, zirconium, uranium or other strange alloys, but my own idea is that the use of clean, well-melted crucible or electric steel is a more probable explanation. Crucible steel was employed for many submarine crankshafts, and apparently the Germans recognize that when fabricating and machining costs are far in excess of material cost, and where dependability is a vital necessity, it is a poor policy to save at the spigot and let out at the bunghole. Quality depends upon the selection of raw materials, the process of melting and subsequent care in forging and heat-treating. The electric furnace provides a reducing atmosphere in which sulphur is readily removed and with it goes one of the generally recognized inclusions, manganese sulphide, and the same condition serves to eliminate oxides.

The electric furnace, therefore, is a potential source of clean steel which is more highly appreciated than formerly, and the electric product is opportune to meet the new and exacting requirements for ordnance, automobiles and airplanes, and other devices in which alternating stresses are very severe. The importance of clean steel has been observed in the course of extensive investigations of the fatigue of metals under the direction of Prof. H. F. Moore. It is not too much to expect that the higher the elastic or proportional limit resulting from heat-treatment the more serious would become defects such as non-metallic inclusions and seams in parts made from inferior steel. Dr. McCance confirms this in stating that fatigue failure under repeated stress is a progressive failure, starting in all cases in some defect or irregularity either of internal structure or external surface.

Freedom From Inclusions

By way of illustrating the freedom from inclusions in electric steel, I might mention the result of actual count of hairlines, due to inclusions, in the ground surface of steel to the same chemical specification—a chromium-nickel steel for airplane crankshafts. As the result of tests on several heats of this steel by the basic, and acid open-hearth and basic electric process, the average count ran in the ratio of 8 to 4 to 1, and the hairlines in the electric steel were much shorter than in the steel of open-hearth manufacture. Another illustration from my own experience may be convincing. In one of the races at the Indianapolis Speedway a few years ago, about one-half of the cars starting did not finish because of failure of vital parts. The following year nine or ten cars, which I knew contained our electric furnace product in their important parts, all finished the race without mishap, and included the winning car. A practical demonstration of this kind is more eloquent than columns of figures of laboratory tests. The recent paper by W. J. Priestley[4] outlines the splendid results of electric furnace ordnance steels made at Charleston, W. Va., in the largest furnaces in the United States. He shows that the results are due to clean steel and freedom from oxides, sulphur and phosphorus. These results show that large units, with proper handling, can produce very high-quality steel, and we see no reason, now that larger electrodes can be made of dependable quality, why a 60- or 80-ton furnace cannot be expected to give relatively as satisfactory results. The electric steel rail is still a desired possibility. The increased demands made upon materials of construction call for new methods for meeting those demands. As I stated here 6 years ago, the electric furnace was opportunely invented to meet a new demand rather than to replace an old process.

Recent Improvements

It would be mere repetition to restate here the various types of furnaces, such as arc, induction, radiation, etc. They have been described in books and technical magazines and we need only observe in passing that there have been no new principles of heating employed since the first few years—with the possible exception

[3]"The Triplex Process of Producing Electric Steel at South Chicago," Yearbook American Iron and Steel Institute, 1918, p. 115. Reprinted in *Chem. & Met.*, July 1, 1918, vol. 19, p. 15.

[4]"Effect of Sulphur and Oxides in Ordnance Steel," *Trans.*, A.I.M.E., vol. 67, p. 317 (1922). Abstracted in *Chem. & Met.*, vol. 21, p. 259.

of Dr. Northrup's high-frequency induction furnace[8] which has not thus far been successfully employed in units of commercial size in the steel industry. Of mechanical and electrical refinements there have been many, all in the nature of improvements in regulation and economy. Among these may be mentioned two of American origin, J. A. Seede's automatic electrode regulator and E. T. Moore's peak-load regulator. The principle of dual, or rather multiple, voltages was embodied in our original installation in 1906, but its metallurgical significance was not so apparent as it was later when we installed a process employing a 220-volt arc and with considerable difficulty succeeded in persuading the inventor that provision for a lower voltage for use during the refining period must be provided. The desirability of relatively high voltage for melting and low voltage for refining is now generally recognized. Many improvements have been made as the shortcomings of the earlier furnaces appeared, such as well-fitting doors, water-cooled arches, better electrodes and holders and economizers to cut down oxidation and waste of the electrode. I have seen electrode costs per ton of product as high as $8 gradually decline to 35 cents. This was in a furnace refining molten charges.

Possibilities of the Future

The electric furnace is also a recognized factor in melting non-ferrous alloys, such as brass and Monel metal, as well as special alloys such as "Nichrome," "Rezistal," "Stellite," stainless steel, manganese steel and high-speed steels, besides an endless variety of the simpler alloy and carbon steels from the mildest to the hardest tempers. As stated earlier in this paper, its astonishing flexibility—versatility, we might call it—has attracted the attention of the metallurgical world in almost every branch of smelting, melting, refining, heating and even baking metals. To those of us who have watched its growth from the start, it seemed very slow in achieving the recognition we felt must inevitably come to it, but at last our early confidence has been confirmed in every steel-making country, because its products have fulfilled almost every expectation in every field wherein it has been thoroughly tried. The present success is due not only to the original inventors of the basic processes but also to the active co-operation of the great manufacturers of electrical equipment, furnace designers and builders, makers of refractories and electrodes and a group of earnest metallurgists in many plants who have studied every detail of operation.

When users acquire a full appreciation of what clean sound steel means in terms of national efficiency, safety and economy we shall see more rapid growth than has as yet been seen. Its usefulness to engineering and industry has just begun.

[8]American Electrochemical Society, meeting held April 3, 1919. *Chem. & Met.*, vol. 21, p. 259.

New Basis for Chilean Nitrate Prices

At a reunion of the nitrate producers, held in Valparaiso, Chile, and reported by Vice-Consul B. C. Matthews, of Antofagasta, Chile, it was decided to eliminate the confusion resulting in quoting prices in Spanish quintals by making all future quotations on the basis of the metric quintal of 100 kilos. On this basis the following prices have been fixed for the year 1923: from Oct. 1, 1922, 20s.; from Oct. 16, 1922, 20s. 6d.; from Dec. 1, 1922, to April 20, 1923, 20s. 8d.; May, 1923, 19s. 9d.; and June, 1923, 18s. 6d.

Effect of Manganese in Steel

Some work has recently been done at the Bureau of Standards on an extensive series of low-manganese steels with carbons ranging up to 1.6 per cent and manganese up to 2.0 per cent, prepared of pure materials, in order to determine the change in physical properties caused by adding manganese to plain carbon steels.

The effect of manganese, as observed in annealed alloys, is to confer upon the pearlite a very fine grain or sorbitic structure, even after slow cooling. The relative amount of pearlite present is considerably greater in the alloys of high-manganese content than in corresponding ones low in this element. The addition of manganese causes a shift in the eutectoid ratio toward lower carbon content. One per cent manganese lowers it to approximately 0.78 per cent carbon.

A pronounced increase in Brinell hardness of the annealed alloys accompanies the change in structure produced by the addition of manganese.

In the normalized alloys, a pronounced decrease in grain size was found in those of high-manganese content in addition to the structural effects mentioned above. In the annealed specimens, no noticeable difference in grain size was detected for high- and low-manganese content in alloys of any given carbon content. The well-known effect of manganese in lowering the transformation temperatures of the materials will account in part for the observed structural changes.

It appears also that manganese renders steel more sluggish and less responsive to structural changes than many of the other elements which produce a similar lowering of the critical temperatures. While the results of the structural examination will not warrant any definite conclusions concerning the use of manganese as a strengthening element in steel, the results obtained strongly support previous recommendations which have been made by different metallurgists concerning the advantages to be gained from the use of higher manganese, particularly in low- and medium-carbon steels.

German Potash Situation

Commerce Reports for Sept. 25, 1922, summarizes the German output and domestic consumption of pure potash as follows for the years indicated below:

Years	Output, Tons	Consumption, Tons
1913	1,110,362	557,000
1921	921,146	720,000
1922 (estimated)	1,250,000	850,000

There has been an increased use of potash in fertilizers for German soil because of the shortage of phosphoric acid. Only 268,000 tons of phosphoric acid was applied in 1921, as compared with 630,000 tons used in 1913.

It is estimated that the former German potash mines in Alsace will yield 120,000 tons of potash in 1922 and that the Alsatian export capacity this year will be from 50,000 to 60,000 tons, while the German export capacity is estimated at 400,000 tons.

The reported accord between German and Alsatian potash groups to establish a monopoly and raise prices has been denied by officers of the German Potash Syndicate.

The German price of muriate of potash c.i.f. American Atlantic ports is now $32.95 net per ton, as compared with $35 in 1913; and kainite is quoted at $6.70 at present, compared with $7.50 in 1913.

Modern Byproduct Coking

By Joseph Becker
Consulting Engineer, the Koppers Co.

*With Special Reference to the New Koppers Combination Oven**

BEFORE entering into the subject of this paper, perhaps it would be well to mention briefly the remarkable development which has taken place in the byproduct coke industry in the United States in the past decade, particularly in its relation to the iron and steel industry, with which it is so closely identified.

Not quite 15 years have elapsed since the United States Steel Corporation installed its first byproduct coke plant of Koppers design at Joliet, Ill., and since blast-furnace operators were looking with doubt and suspicion on the byproduct coke oven as a source of blast-furnace fuel; but in this comparatively short time the byproduct coke oven has come to be an essential part of an economically operated iron and steel plant.

European Coking Practice

It is no idle boast to say that American byproduct coke-oven practice leads the world today, this despite the fact that the byproduct coke oven originated and was in general use on the continent before it was even thought of in the United States. The writer had an opportunity last year to visit Europe and to study European byproduct coke-oven operation very carefully. What he saw convinced him that European practice is 10 years behind ours. That very little, if any, progress has been made there in the past 10 or 15 years is brought out very clearly in an article in the Sept. 2 issue of *The Gas World* of London, describing an installation of 100 ovens for the purpose of carbonizing 540 tons of coal per day. This article goes on to say that the plant previously consisted of 100 horizontal-flued waste-heat ovens which have been in operation for 15 years. These ovens have a capacity of 7 tons and the 100 ovens carbonize 500 tons of dry slack coal per 24 hours. This would be equivalent to 31 hours' coking time. The additional 100 ovens recently completed are of the vertical-flued type, and have a capacity of 7½ tons each, with a carbonizing capacity of 540 tons of dry slack per day. This would be equivalent to a coking time of about 33 hours.

This very strikingly shows that at least in this plant no progress has been made with respect to increasing the coking capacity per oven. It is remarkable that after 15 years a new plant is built which has even less carbonizing capacity per oven per day than the old plant, in spite of the enormous progress that has been made in the United States during the same period in the way of increasing oven capacity. This is merely citing one instance of English coking practice, and the majority of English coke plants operate under very similar conditions.

The writer observed similar things during his last year's visit in Germany. There have been recently put into operation ovens of the Koppers type, which are heated with blast-furnace gas and which are supposed to operate on 18 hours' coking time. These have an average width of about 16 in. and a length of about 32 ft. between doors, making a carbonizing capacity of about 14½ tons per oven per day. This is very likely the largest capacity of any type oven of similar dimensions in Europe. However, even this capacity is low when compared with American coke-oven capacities. Modern American ovens carbonize more than double the quantity of coal per day that can be coked in ovens as built in Germany and England.

Difference Between European and American Practice

The question now arises, What is the reason for this great difference in coking speeds? Many have been advanced by our European contemporaries, the most prevalent of which is that they have to carbonize wet-wash coals and that this makes it impossible for them to attain the same coking speeds possible here. This does not sound quite reasonable, and furthermore, it is a fact that several plants in this country are using washed coals averaging 12 per cent moisture and more, and carbonizing them in from 15 to 17 hours in Koppers ovens averaging 17 in. in width.

Another reason given is that the character of their coals is quite different from those found here. The writer has made an examination of the analyses and coking qualities of the various coals found there, and in general they correspond very closely to the coals found in this country, so this argument does not seem to hold.

Most striking proof of the fallacy of both these arguments was given during our recent coal strike, where several companies operating byproduct coke plants imported large quantities of English coals to avoid curtailing operations. The Seaboard Byproduct Coke Co. at Jersey City, N. J., received over 100,000 tons of English coals such as Yorkshire and Durham coals, and coked them in 16 hours continuously with the same ease as other American coals of different varieties used there, producing coke of very good quality for metallurgical purposes (see Figs. 1, 2 and 3). About 100 tons of Yorkshire and Durham coals were sent to the Chicago Byproduct Coke Co.'s coke plant and separate coking tests were made in the new five-oven battery. These coals were perfectly coked at a coking time of 11 hours without the slightest difficulty and the coke produced was just as good for blast-furnace use as any coke made in the Pittsburgh district from Pittsburgh coals. (See Figs. 4 and 5.) The capacity of this oven on these coals is, therefore, 25 net tons per oven per day.

Unquestionably one reason for their not being able to attain our coking speed is the fact that they do not generally use silica construction. On the other hand, there are ovens of this material over there; but these have not attained anything approaching American practice.

Organization the Keynote of Operation

The organizations operating the coke ovens in America consist generally of technically trained men with good practical experience, the latter not being gen-

*Abstract of paper presented at the recent meeting of the Eastern States Blast Furnace and Coke Oven Association at Buffalo, N. Y.

Fig. 1—Coke from 100 per cent Yorkshire coal coked at Seaboard Byproduct Coke Co.

erally the case in Europe. American operators have more tenacity in solving problems and difficulties in organization and operation in order to attain greater capacities from their plants and do not offer excuses for inability to maintain a high output as is done abroad.

One of the most important features of organization to be found on American coke plants is the strikingly systematic operation of the ovens. Ovens are heated by intelligent heaters and most of the assistants and superintendents of American plants have passed through the entire school of byproduct coke-oven operation, beginning as heaters. Even in cases where this is not so the assistants and superintendents fully realize the importance of even heating and consider the oven operation the "heart" of the entire byproduct coke plant.

In European operation, on the other hand, insufficient talent and talent of a lower quality are employed to take care of the ovens. The result is that coke-oven batteries need frequent repairs and relining, often after only 3 to 5 years of operation. In making this statement I do not refer to plants using highly expanding coals or coals containing excessive amounts of sodium chloride and which are coked in clay ovens instead of in silica ovens. The usual class of heaters employed in Europe are men who are not acquainted with combustion problems and who operate the ovens by rule-of-thumb methods. In most plants it will be found that there is no pushing schedule at all. Ovens are picked out and pushed as they become ready, so it can be stated as a general rule that the ovens on the continent operate the heaters, while in America the heaters operate the ovens.

Another excuse usually offered is that with our fast operation we destroy byproducts. The writer had an opportunity to investigate this and finds that the byproduct yields here are fully equal to those obtained in Europe.

Tendency of Modern American Designs

The development in America has been a gradual increase in the size of the ovens. The use of high-grade silica throughout the structure has reduced the time required for coking considerably as compared with the use of clay bricks. But beyond the increase of capacity due to the use of silica in the building of long and high ovens there was necessary an improvement of the design of the ovens proper to make it possible that long and high ovens could be built with proper heat distribution over the considerably increased coking areas.

The problem of designing ovens which would assure a perfect distribution of heat over such large areas was a difficult one. A great number of coke plants were desirous of coking 100 per cent high-volatile coals. The blast-furnace practice showed that coke made from such coals should be pushed at relatively lower temperatures. When pushing coke made at low temperatures, any uneven heating conditions in the ovens becomes much more pronounced and visible than when pushing hot coke. Furthermore, it is a matter of course that the heating system of ovens of large capacities has to permit passage of larger volumes of gas such as waste products of combustion through their flues.

Testing for Coking Temperatures

Fig. 6 shows a typical progression of temperature into the coal charge at various places in such an oven. These readings were taken by inserting thermocouples through the pusher side door 4 ft. into the coal charge; one was located 2 ft. above the oven floor, one just below the horizontal flue and another one at about the center line of the horizontal flue.

The figures given herein are an average of a great number of readings and exhibit in general the conditions as they exist in practically all the Koppers coke ovens which are heated reasonably well and operated to capacity. This indicates that the space occupied by the horizontal flue is quite appreciable and the amount of coke in the upper region of the ovens being affected by

Fig. 2—Coke from 100 per cent Durham coal coke at Seaboard Byproduct Coke Co.

Fig. 4—Coke from Yorkshire English coal coked in five-oven battery at Chicago in 11 hours.

the location of the horizontal flue is an appreciable percentage of the total coke made. This condition is tolerable, particularly when the ovens are pushed without waiting until the upper part is thoroughly coked, and such coking operations with these ovens have given very good blast-furnace results. These ovens have an average capacity of about 18 to 19 net tons of coal per 24 hours.

It will be interesting to note the results of an investigation of the heat progression in the coking charge in an oven that was designed for 17 hours' operation, but operated between 23 and 24 hours. Such tests were made at the Seaboard Byproduct Coke Co.'s plant by inserting thermocouples in the coal charge in the same way as in the tests described before. The test disclosed that on that coking time the lower part of the oven coked decidedly faster than the part below the horizontal flue. When the lower part of the coke reached the temperature of 1,890 deg. F. the part below the horizontal flue had a temperature of only 1,450 deg. F. These temperature differences could, of course, be expected, because when operating on a longer coking time the quantity of gas per flue becomes correspondingly less and combustion is relatively quicker, thus causing a quicker progression of the coking in the lower part as compared with the upper part of the oven.

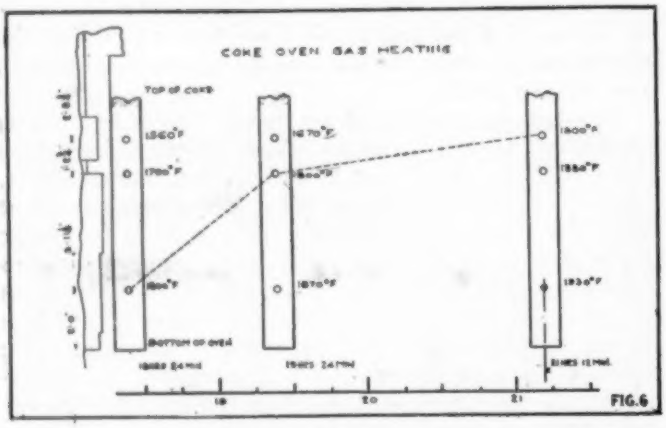
As far back as 1914 Dr. Koppers proposed, as a means of evening out temperatures within the heating system of coke ovens, the addition of waste gases to the air required in order to retard the combustion of gases in the heating flues because of the reduced content of oxygen in the waste gases and air mixture and thus lengthening the flame, resulting in an improved heat distribution and temperature progression within the coal charge. This process was tried out at Seaboard and Fig. 7 shows the result of the addition of waste gas till the mixture of waste gas and air contained 12 per cent oxygen. The waste gas was taken from the stack by means of a fan and blown into the air boxes on the regenerators, while the air was drawn in according to the regular practice.

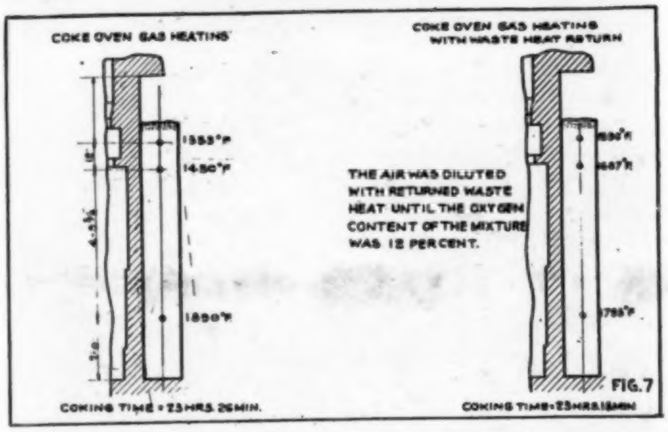
This test was carried on for several weeks and it was shown that when the fan was taken off the temperature went back to the original ones as mentioned before. This test proves that the return of waste gases in ovens which have unequal heating conditions from bottom to top will greatly help the distribution of heat progression in the coking charge. It is a good cure for ovens which suffer from hot bottoms, as it causes a condition in the heating flues which is similar to that existing when using blast-furnace or producer gas. Blast-furnace and producer gas are most excellent fuels for heating the ovens, because such gases have a slower combustion speed and distribute the heats very uniformly.

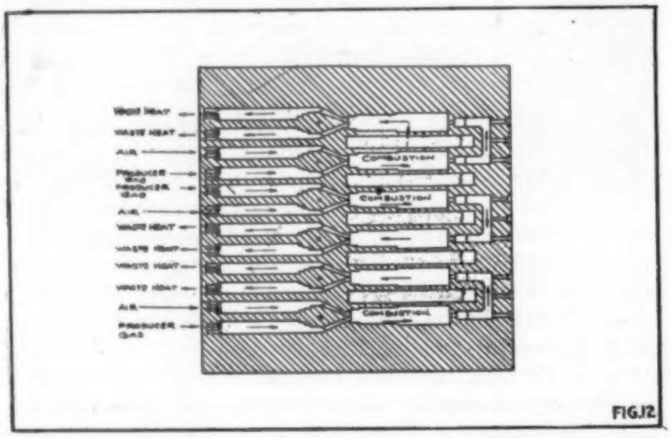
How Capacity Effects Design

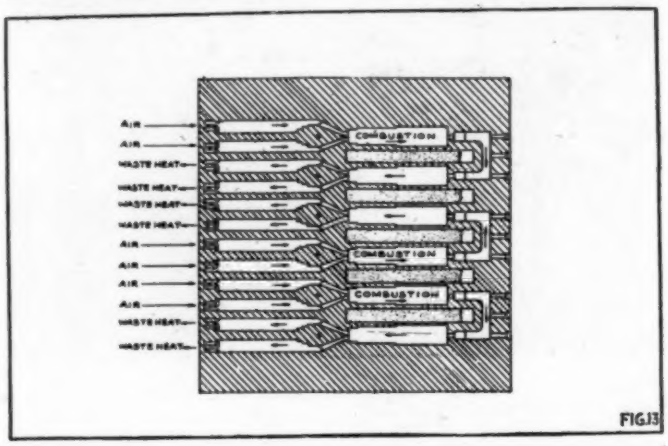
It is the belief of the majority of coke-oven and blast-furnace operators that, especially from high-volatile coals, better coke can be made in narrower ovens. In making the oven narrower, the coking capacity per 24 hours would necessarily be reduced unless a considerable multiplication of the operations would be resorted to. The first thought would naturally be to compensate for this by building higher and longer ovens and thus increasing the tonnage per oven per 24 hours. This would mean that the horizontal flue, with the type of oven as mentioned before, would have to be enlarged and thus occupy a larger space in the coking region, thereby retarding the coking of a proportionately larger amount of coal in that region. Furthermore, when equipping ovens so that they can be heated in the future with producer or blast-furnace gas, this flue must

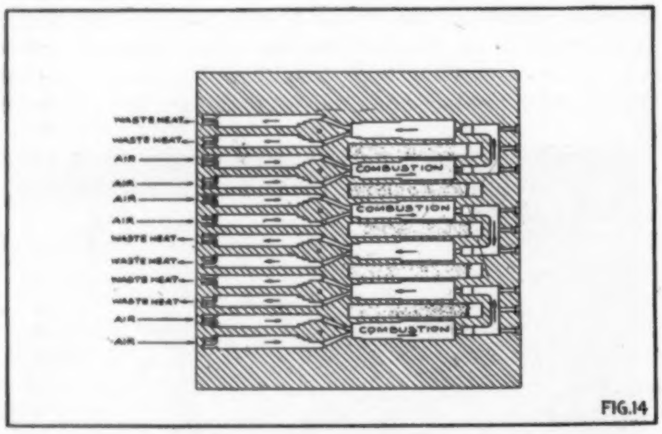
Fig. 5—Coke from Durham English coal coked in five-oven battery at Chicago in 11 hours.

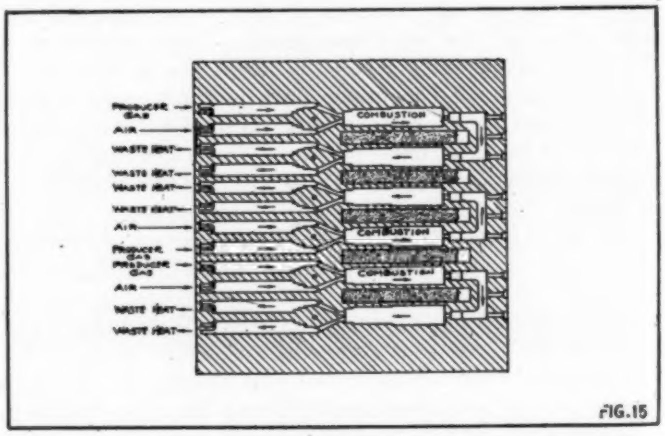


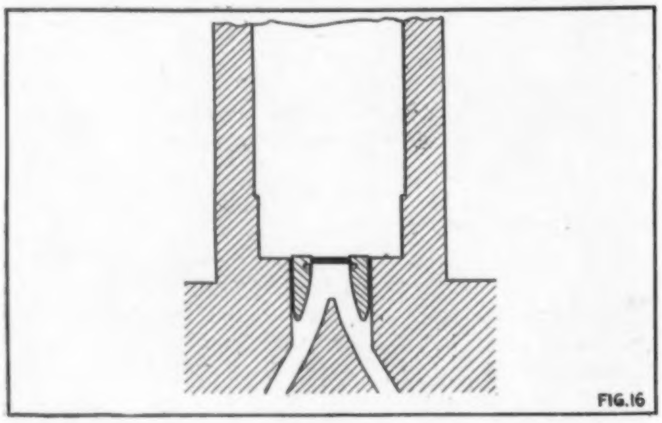












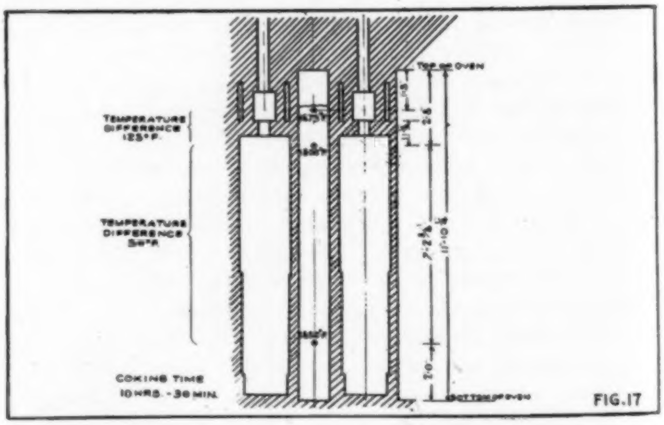


Fig. 6—Heat progression chart, old type Koppers oven.

Fig. 12—Producer-gas heating.

Fig. 14—Coke-oven gas heating.

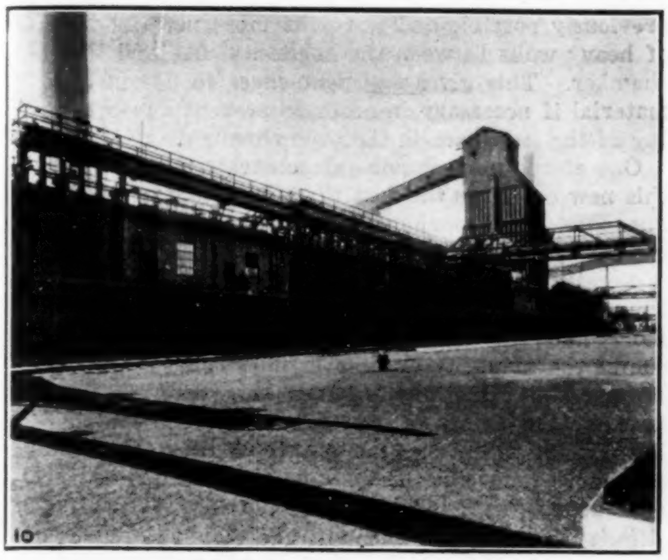
Fig. 16—Adjustable air port, new Koppers oven.

Fig. 7—Heat progression chart, waste heat return.

Fig. 13—Coke-oven gas heating, reversal.

Fig. 15—Producer-gas heating, reversal.

Fig. 17—Heat progression chart, new Koppers oven.



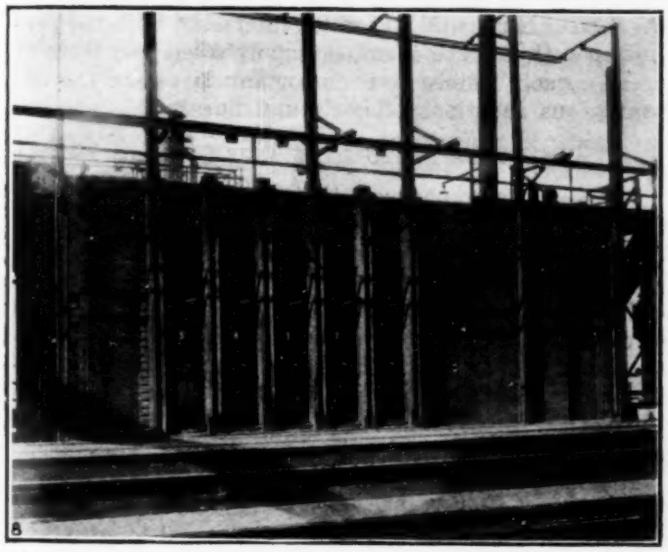
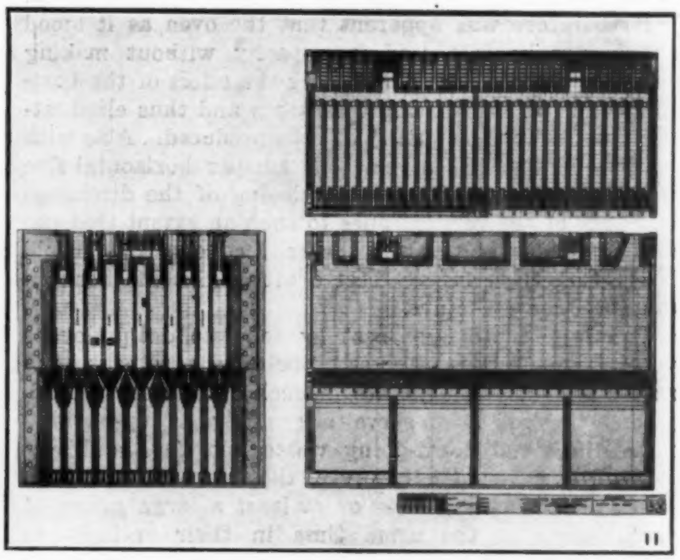
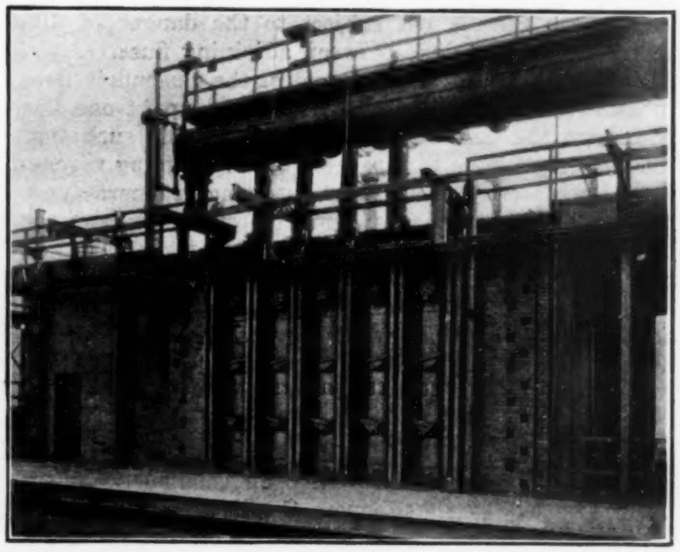


Fig. 10—Pusher side ovens at Chicago Byproduct Coke Co. New ovens in foreground.

Fig. 8—Coke side of new ovens at Chicago.

Fig. 3—Coke section 100 per cent Durham coal coked at Seaboard Byproduct Coke Co.





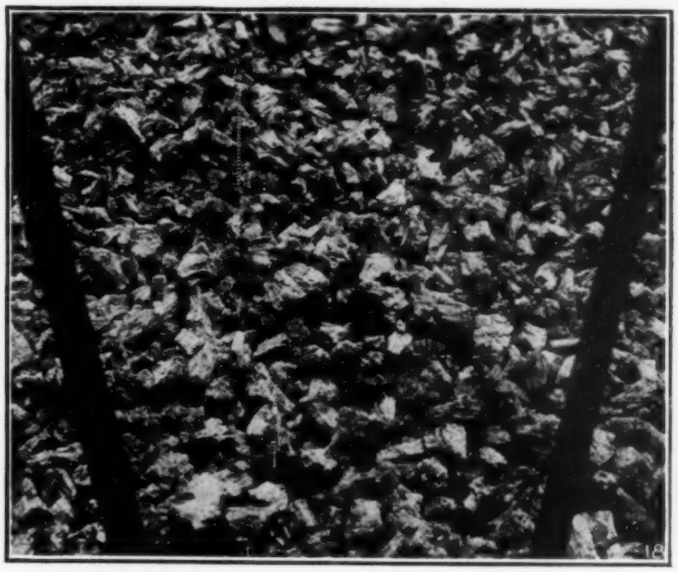


Fig. 11—General design of new oven.

Fig. 9—Pusher side of new ovens at Chicago.

Fig. 18—Coke from 100 per cent Black Briar Illinois coal.

be enlarged again in order to make it carry the additional amount of inerts present in such low B.t.u. gases.

It therefore was apparent that the oven as it stood should not be increased in capacity without making changes in the design eliminating the effect of the horizontal flue on the heating conditions and thus eliminating its effect on the quality of coke produced. Also with increased capacities a relatively smaller horizontal flue would require an exaggerated closing of the discharge openings of the vertical flues to such an extent that the drop of pressure through the reduced openings would become too high for the best draft conditions throughout the oven structure.

It might be thought best by some to design ovens without any horizontal flues. Such ovens without horizontal flues usually operate in such a manner that adjacent vertical flues serve alternately as up-burning flame flues and down-going waste gas flues and vice versa. It is evident, however, that an oven in which all adjacent heating flues or at least a large group of them serve at the same time in their entirety as up-burning flame flues or in their entirety as down-going waste heat flues is not subject to the danger of different draft conditions between adjoining flues.

Furthermore, the arrangement of the gas-supply flues in an oven in which the gas is burned up in one flue and down the next adjoining one is usually such that this gas-supply flue is paralleled by an up-going regenerator on the one side and a down-going regenerator on the other side. This arrangement greatly increases the difficulty of keeping the gas-supply flues tight. Also all ovens should be built so that producer gas or blast-furnace gas could be used advantageously in the future, and in up- and down-flow flue ovens there will always be a counter-current between waste gas and gas in regenerators, as well as between adjacent flues.

The New Koppers Combination Oven

These leading principles in oven construction have been tried out by the Koppers Co. in a battery of five ovens at the plant of the Chicago Byproduct Coke Co. at Chicago. The five ovens were put into operation on Feb. 1, 1922, and have since that time operated continuously on a great variety of coals at coking times between 10 and 12 hours. Fig. 8 shows the coke side of this battery. Fig. 9 shows the pusher side, and Fig. 10 shows the location of this battery in connection with the rest of the ovens. The new oven has a length of 37 ft. between doors, a height of chamber of 11 ft. 8 in. and an average width of 14 in., the taper between coke side and pusher side being 1½ in. Cast-iron jambs are used at the ends of the ovens. Fig. 11 shows the general design of the new type oven.

Heating in the New Oven

This shows that in this new design one side of the coke oven is heated in its entirety—that is, gas burns simultaneously on the coke side and on the pusher side—the products of combustion then join in the respective horizontal flues, pass through the crossover flues, one of which is located on the coke side and the other on the pusher side. Thence the products of combustion enter the respective horizontal flues of the adjacent heating wall and pass downward throughout the entire wall into the respective regenerators.

It is evident that the cross-sectional area of a horizontal flue when operating in such a way as described above can be considerably reduced as compared with the horizontal flue in ovens of the former design. This permits us to locate the horizontal flue higher than was previously possible and it furthermore permits the use of heavy walls between the horizontal flue and the coal chamber. This gives sufficient space to use insulating material if necessary in order to prevent any overheating of the gas space in the oven chamber.

One of the most important achievements claimed for this new design is the fact that the height of the flame flues has been considerably increased and these now extend as far up toward the top of the coal charge as is necessary for uniform heating of the entire charge. Thus the interference of the horizontal flue with the flame flue heating has been entirely eliminated. Of course the number of crossover flues could be increased beyond two preferably to five, the crossovers passing through the available spaces between charging holes. The size of the horizontal flue would thus of course be still more reduced, without causing an additional pressure drop.

It is clearly shown that with this new design the size of an oven has become independent of areas required for the former horizontal flue which interfered with the perfect operation of the ovens, especially when they were of great capacity, since it is important to retain the advantageous functions of horizontal flues.

Other Features of This Oven

It should be emphasized that on account of the fact that an entire side of a coke-oven chamber serves either for up-flow combustion or down-flow products of combustion, any leakage between individual flues becomes of little consequence, because all the gases flow either up or down and each flue is operating under the same pressure conditions. Since there is absolutely no counterflow in any of the heating flues, it undoubtedly constitutes the safest construction for flame-heated coke ovens.

It will also be noticed that the regenerators reverse longitudinally with the battery instead of crosswise as used in the former design. The usual longitudinal taper of a coke oven requires that larger amounts of fuel gas are used on the coke side as compared with the pusher side. In the type of oven formerly built, products of combustion from the coke side of the oven chamber exchange their heat with the air or air and gas going up to the narrow pusher side. Since for the latter side gases are required in smaller volume, the efficiency of the heat exchange varies with reversals, as is shown by fluctuations in the stack flue temperature. In this new construction the in-going gases for each half of the oven are regenerated with the products of combustion from that half, and it is thus possible to maintain a lower uniform stack temperature which is the nearest practicable approach to the theoretical.

Flow of Gas in New Oven

The four drawings, Figs. 12, 13, 14 and 15, show the flow of gases when using coke-oven gas and blast-furnace or producer gas. Figs. 14 and 15 show the oven when operating on producer or blast-furnace gas. When producer gas or blast-furnace gas of low heating value is used for heating the ovens, it must be preheated in order to obtain the desired temperature and to operate economically. This preheating is accomplished by passing the gas through separate regenerating chambers on its way to the heating walls. In the new design of oven the arrangement of regenerators and flow of gases

is such that there does not exist at any time a counter-flow between incoming fuel gas and outgoing products of combustion in adjacent regenerator chambers. Fuel gas and outgoing products of combustion are always separated by a regenerator containing ingoing air. Should there be a slight leakage into the waste gas regenerator chambers, it would only result in loss of air, while it would be impossible to lose producer or blast-furnace gas.

Results Obtained From Test Battery

The battery of five ovens of this new design at Chicago was operated on 11 hours' coking time for several months with producer gas having a heating value purposely varied between from 85 to 125 B.t.u., and it was demonstrated that the oven when heated with this producer gas gave most satisfactory result as to heat distribution and fuel consumption. It was absolutely evident that there was no leakage of producer gas into waste gas on account of producer gas and air flowing in parallel and a counter-flow only existing between air and waste gas.

It has been demonstrated that on the five ovens at Chicago the arrangement of adjustable ports (Fig. 16) in that construction is correct for both conditions—that is, when using straight coke-oven gas or producer gas. The same small temperature difference between top and bottom when using coke-oven gas was observed as when using producer gas.

The tests for determining the progression of coking at different elevations in the oven chamber as made at the Providence plant were repeated with the same instruments and in the same manner on these five ovens at Chicago, and the results obtained were most gratifying. (See Fig. 17.) The absence of the interference of the horizontal flue, together with the unique design of adjustable air ports, gave a distribution of heat in such a way that the entire mass from top to bottom and from end to end was finished at the same time, the difference in temperature usually not exceeding 100 deg. F.

Coke Produced From New Ovens

The coke produced from these new type ovens was decidedly more uniform than that produced from the older ovens. The large pieces of coke originating near the horizontal flue region of the older oven were entirely absent in the coke from the new oven, and the coke from the bottom part of the new oven was just as large as the coke from any other part of the oven.

Shatter tests and combustion tests have been made from coke out of different elevations of the new ovens, and it has been found that the combustibility of the coke from the lower part of the ovens is the same as that taken from the upper part of the ovens. It was further shown that the shatter tests from the upper part of the oven are virtually the same as the shatter tests from the coke produced in the lower part of the oven.

In making coke of 11 hours in this new design of oven, the temperature of the flue walls did not exceed the maximum of 2,550 deg. F. and the fuel consumption in coking Pittsburgh coals was equivalent to 1,050 B.t.u. per pound of coal.

Advantages Claimed for New Oven

1. Greatest simplicity of design.
2. Perfect distribution of heat in such a way that the coking within the coal charge progresses uniformly at all places, thus preventing any over and under coking.
3. Increased capacity per oven unit.
4. Lowest fuel gas consumption.
5. Maximum strength of oven walls.
6. Lowest pressure differentials throughout the entire oven system.
7. Complete absence of counter-flow between flame flues and gas supply flues and gas regenerators.

All of the above-mentioned improvements will guarantee the long life of the oven structure and the continuous supply of most uniform coke at the lowest fuel consumption and operating expense. The low draft conditions existing in these ovens is of great importance, because it insures long life of the ovens.

Deductions From Operation of New Ovens

The foregoing shows that the coking of coal can be done in the most uniform manner, and the only matter to be decided upon in individual cases would be the width of oven that would be proper for certain coals to produce the best blast-furnace coke in respect to size of coke and its properties as to combustibility. Furthermore, at what temperatures or in length of time should coals be coked to produce the coke that gives the best blast-furnace results. From all observations made so far it seems to be correct for straight high-volatile coals to build the ovens as narrow as is practical, because this produces a coke of less fingery structure and cross-fracture than when made in wider ovens.

There is usually a variation in the coke starting with the wall side and ending at the center of the oven. This variation is greater in wider ovens than in the case of coke made in narrow ovens. In making tests of a piece of coke and taking samples from the inner end of the coke, the middle and the outer end of the coke, it has been observed that the specific gravity and porosity of the coke changes from center to end and that in wider ovens the cauliflower and dense end penetrates to a greater depth than in narrower ovens. It has been observed in the coke made in the five-oven battery at Chicago that a much more uniform porosity was practically maintained from one end to the other of a piece of coke.

Coals coked in narrow ovens give a higher yield of tar than when coked in wide ovens, indicating that the smaller yield of tar must have been accompanied by formation of additional gas and residue of carbon which is deposited on the cell walls of the coke. However, carbon coke made from tars is very refractory and combustion tests on carbon coke made from tar subjected to a temperature corresponding to that of coking operation—that is, about 1,800 deg. F.—showed that the combustibility of such material was decidedly less than the combustibility of ordinary coke. This would again indicate that a given coal when coked under conditions which yield the maximum in tar would produce a coke of greater combustibility than when coked under conditions where the tar yield is relatively low.

Author's Note—Figure 18 shows a photograph of coke on the coke wharf at the Chicago Byproduct Coke Co. made from Black Briar Illinois coal, such as is coked at a plant in the Mississippi Valley. Much has been said about a mysterious way of coking so-called non-coking Illinois coals at this plant. The coals which have been coked there and which have been called non-coking are in fact coking coals without any mystery whatsoever about them, and such coals have been coked in the oven described in this paper in 12 hours' coking time. Furthermore, thousands of tons of such coal have been coked at several other plants of Koppers ovens. (See Bureau of Mines Technologic Paper 137, by R. S. McBride and W. A. Selvig, Nov. 17, 1919.)

The Properties of Cold-Worked Metals

Properties of Cold-Worked Metals Explained by a Series of Postulates Regarding Conditions at Slip Planes—General Theory Checked by Experiments on Copper, Nickel, Iron, Molybdenum and Tungsten

BY ZAY JEFFRIES AND R. S. ARCHER

MOST metals are hardened by working at ordinary temperatures. Tin and lead anneal rather quickly, so that a quick test is required to detect much hardening. Zinc also anneals at room temperature, but more slowly, so that considerable temporary hardening can be produced. The tensile strength of the ordinary metals like iron, copper and aluminum is increased from two to three times by commercial cold-working processes. The plasticity of a metal has probably never been exhausted by cold-working, since with sufficient care an almost unlimited amount of work may be carried out. Copper can be cold-rolled from a slab $1\frac{1}{2}$ in. thick to sheet having a thickness of 0.002 in. Copper can also be easily cold-drawn until its length has been increased 5,000 times. Tungsten has been extended 200,000 times in length by drawing below its recrystallization temperature. By this it is not to be understood that extremely high reductions by cold-working are always practicable or desirable, but merely that they are possible.

HARDENING BY COLD-WORK

While the general effects of cold-working are an increase in hardness and loss of plasticity, various specific properties are affected in somewhat different ways. As noted in a previous article,[1] when discussing overstrain, the elastic limit of iron is lowered sometimes to zero by cold-working, but is restored by aging or heating at low temperatures to a value which may be much higher than its original value. It has also been shown that the elastic limit of cold-worked brass may be raised from 22,400 lb. per sq.in. to 44,800 lb. per sq.in. by low-temperature heating. There is a lack of exact information regarding the effect of cold-working and aging on the elastic properties of other metals. Beilby[2] tested the elasticity of metals by making reed vibrators of them and observing the pitch and intensity of the notes produced. He found that cold-worked copper, silver and gold gave notes of greater intensity (i.e., had a greater amplitude of vibration) but lower pitch (lower frequency of vibration) than when annealed. This indicates that the cold-worked metals are less perfectly elastic than the annealed metals or have a slightly lower modulus of elasticity, but that they are elastic or nearly so up to much higher stresses.

The yield point is probably affected by cold-working more than any other property of the hardness group. While the tensile strength of iron (in wire) is raised from 48,000 lb. per sq.in. to 125,000, the yield point is raised from about 25,000 lb. per sq.in. up to a value practically identical with the tensile strength. Similar results are obtained with other metals, the ratio of yield point to tensile strength increasing markedly as cold-working progresses.

Figures are often given, particularly in handbooks, indicating that the elastic modulus is greater in the cold-worked than in the annealed condition. Such results are reported especially for the softer metals and alloys like copper and brass, whose true elastic limits are quite low when in the annealed condition. The lower moduli reported for the annealed metals were probably calculated from stresses which exceeded the true elastic limit. If there is any real difference in modulus, that of the annealed metal is probably the greater.

The hardening effect of cold-work is indicated to somewhat different degrees by the various tests for hardness. The scleroscope shows the greatest effect, followed by the Brinell test, while the sclerometer (indicating scratch hardness) shows little difference between cold-worked and annealed metal.

Resistance to repeated stresses is increased by cold-working. This is particularly noticeable in the softer metals, which can be used for springs when cold-worked, a service for which they are entirely unsuited when in the annealed condition.

The effects of cold-working are directional.[3] The increase in elastic limit and yield point are greatest in the direction of working, and there may even be a decrease in elastic limit under forces applied in the opposite direction. Cold-rolled or cold-drawn metals are generally used in such a way that the service stresses are in the same direction as the working stresses.

Elongation is reduced by cold-working. After very severe working the elongation before rupture is almost entirely elastic. The per cent reduction of area is also decreased by cold-working, but to a less marked extent than is the elongation. The reduction of area of a cold-worked metal may even be greater than that of annealed metal of large grain size. For example, a copper rod reduced by cold-swaging from $\frac{1}{2}$-in. diameter to 0.10-in. diameter had a rather high reduction of area. After annealing at 700 deg. C., the reduction of area was somewhat less.

The hardening effect of a small or moderate deformation is greater the smaller the grain size of the metal subjected to such deformation. The strength obtainable by severe cold-working is about the same regardless of the initial grain size, so that a coarse-grained metal which originally has a lower strength than a fine-grained metal must be regarded as possessing greater capacity for hardening by cold-work.

In general the increase in hardness and loss in plasticity are continuous with increasing amounts of cold-work. The rate of change tends to decrease as the amount of work becomes large.

For instance, a discontinuity in the effect of cold-work on the properties of copper has been reported by Alkins.[4]

[1] "Overstrain, Internal Stresses and Creep," *Chem. & Met. Eng.*, vol. 27, No. 17, p. 833, Oct. 25, 1922.

[2] "The Hard and Soft States in Metals," G. T. Beilby, *J. Inst. Metals*, 1911, No. II, p. 5. For a complete account of Beilby's work, see his more recent book, "Aggregation and Flow in Solids," MacMillan, 1921.

[3] "The Effects of Cold-Working on the Elastic Properties of Steel," by J. A. Van den Broek, *Carnegie Scholarship Memoirs*, Iron and Steel Institute, vol. 9; also see *Engineering*, July, 1918.

[4] "The Effect of Progressive Cold-Work Upon the Tensile Properties of Pure Copper," W. E. Alkins, *J. Inst. Metals*, No. II, 1918, vol. 20, p. 33.

He found that when copper was reduced by wire drawing, a stage was reached at which a reduction of area of almost 10 per cent was accompanied by no change in tensile strength. This occurred when the diameter had been reduced from 0.553 in. to 0.373 in. in four successive passes. The tensile strength at this stage was about 52,000 lb. per sq.in. He also reported that wires which had been reduced less than this amount and which had a tensile strength less than 52,000 lb. per sq.in. were stable at ordinary temperatures, whereas wires which had been reduced a greater amount and which shortly after drawing possessed higher tensile strength were in an unstable condition and underwent a gradual reduction in strength at ordinary temperatures. The interruption in the hardening process on continued cold-drawing is probably attributable to spontaneous annealing.

After a metal has been severely cold-worked, further cold-working may cause a decrease in tensile strength. This is the result obtained when wires are "overdrawn." It is usually due to internal failures, such as splitting or drawing hollow. Strength normally increases as cold-working progresses as long as complete continuity of the metal is maintained. If the temperature of working is sufficiently close to the temperature of recrystallization, severe working may cause some annealing.

Commercial Terms for Hardened Metal

Commercially, metals are supplied in various degrees of hardness according to the purposes for which they are to be used. The various grades are designated by such terms as soft or annealed, medium or half-hard, and hard. A specially hard grade of brass is denoted by the term "spring temper." Aluminum sheet is supplied in various tempers designated by numbers which indicate the amount of reduction by cold-rolling subsequent to annealing. When it is desired to produce a finished article by some cold-working operation such as spinning or pressing and to have a certain degree of hardness in this finished article, sheet is selected of such temper that when subjected to the further deformation of the fabricating process it will have the desired final hardness.

The amount of cold-working which is necessary to produce material of any particular hardness is different for different metals. Copper wire is obtained in the half-hard condition by a reduction in section of about 60 per cent. A reduction in section of about 90 per cent is required to produce hard wire. These figures are typical of a pure metal of great plasticity. Less plastic metals and alloys such as brass harden more rapidly.

In general, the hardening effect of a given deformation is greater the lower the temperature at which deformation is effected. This is illustrated by some tests reported by Beilby.[2] Some gold wire was drawn at room temperature so that its length increased from 186 mm. to 352 mm. It was then drawn part way through a final die at room temperature, the remainder of the wire being drawn through the die at a temperature of approximately —80 deg. C. In this final pass the length of the wire was increased 32 mm., making the total length 384 mm.; therefore the total extension of the wire from the soft condition was then 106 per cent.

The tensile strength of the wire which had been drawn entirely at room temperature was 32,368 lb. per sq.in., whereas the tensile strength of the wire which was finished at —80 deg. C. was 35,213 lb. per sq.in. The wire drawn at the low temperature was thus 8.8 per cent stronger than the wire drawn completely at room temperature. Some copper wire treated in the same way showed a tensile strength of 60,928 lb. per sq.in. for the wire drawn entirely at room temperature and 64,960 for the part finished at —80 deg., an increase of 6.6 per cent.

The fact that iron is hardened much more by working in the blue heat range than at certain lower temperatures has been referred to in the former article[1] on "Overstrain, Internal Stresses and Creep," and it has been indicated that this behavior may be a general property of metals, although it is found to an exceptional extent in iron.

With the exception of tungsten and molybdenum, metals are usually worked either above their recrystallization temperatures or at room temperature—that is to say, intermediate temperatures are not intentionally selected for working and probably in no case is an artificially low temperature intentionally used. Work is often applied at temperatures between the recrystallization temperature and room temperature, however, in the natural sequence of operations. Thus ingots of copper or aluminum may be started through the rolls hot—that is, above the temperature of recrystallization—and rolling may be continued while the metal cools down gradually to room temperature. On the other hand, the heat produced by cold deformation itself may raise the temperature of a metal somewhat above the assumed working temperature. It has been estimated that in drawing copper wire presumably at a temperature of about 20 deg. C. the actual temperature may be about 75 deg. C.

Variations in the conditions of cold-working are unlimited in respect to such factors as the stages of reduction, the speed of drawing or rolling and the shape of dies or rolls. Variations in such factors produce slight variations in the properties of the metals, because of uneven distribution of the deformation, or of temperature and time effects. For practical purposes, however, the properties of a cold-worked metal are nearly independent of the manner of deformation.

Cold-Worked Metal at Elevated Temperatures

The properties of cold-worked metals vary with temperature in much the same way as do their properties in the annealed condition. Hardness decreases with rising temperature. Tensile strength decreases with rising temperature throughout the intermediate zone of temperature, but also decreases on cooling into the low temperature region of brittleness. Thus cold-drawn tungsten wire—like annealed tungsten wire—is weaker at liquid air temperature than at room temperature. No other metal so far tested is weaker at the temperature of liquid air (—185 deg. C.) than at room temperature, but most metals probably become weaker at some temperature lower still.

The elongation of cold-drawn wires likewise follows the same general trend as that of annealed wires. As the temperature rises from the cold brittle region, the elongation increases to a maximum value, and then, on further rise of temperature, decreases. The temperature of maximum elongation, however, is lower for cold-worked metal than for annealed metal, at least for those metals whose loss of ductility at low temperatures is due to grain boundary brittleness. It is in accordance with this law that cold-drawn tungsten wire is ductile at room temperature, whereas recrystallized tungsten wire is brittle. At temperatures above that of recrystallization, the effects of cold-working are lost, and the

properties become those of annealed metal, depending upon the grain size established by the conditions of deformation and heating.

When there is a discontinuity in the effect of temperature on the mechanical properties of a metal in the annealed condition, a corresponding discontinuity is found in the properties of the cold-worked metal. For example, the blue heat properties of annealed iron are also found in cold-worked iron, but are less evident as the amount of cold-working increases.

Cold-worked metals are nearly completely annealed or softened by heating under conditions of time and temperature that produce general visible recrystallization. Some softening may occur at much lower temperatures. It has already been mentioned[1] that iron which has been severely cold-worked and aged is softened somewhat by heating at 100 deg. C., although visible recrystallization occurs only above 450 deg. C., and that hard copper wire loses some of its strength slowly at room temperature. It has also come to the authors' attention that springs which depend for their elasticity on hardness produced by cold-work gradually deteriorate to some extent at ordinary temperatures so that they become unfit for certain uses.

Summary of Properties

The following general statements may be made regarding the properties of cold-worked metals:

1. Hardness and strength of a metal increase with the amount of reduction by cold-work until internal failure is produced.

2. Plasticity of a metal decreases as the amount of cold-work increases.

3. With change in temperature of test, the properties of a cold-worked metal follow those of annealed metal, any discontinuities in the properties of annealed metal being reflected in those of cold-worked metal.

4. The effect of a given deformation is greater the lower the temperature at which it is effected, except that in some metals abnormally large effects are produced in a certain region of temperature, corresponding to the blue heat in iron.

5. Elongation of a cold-worked metal increases with respect to the elongation of annealed metal, as the temperature of test decreases below the working temperature, reaching a maximum value, after which further decrease in temperature produces a rapid decrease in elongation.

6. Elongation of a cold-worked metal decreases with respect to the elongation of annealed metal as the temperature of test is raised above the working temperature until the recrystallization temperature is reached, when elongation is increased by annealing.

7. Temperatures of maximum elongation are different for various metals.

8. For any given metal, the temperature of maximum elongation is lower the greater the amount of cold-work, and is in general lower in cold-worked metal than in annealed metal.

9. In metals which become brittle on cooling because of intercrystalline weakness, the cold-worked metal may possess considerable elongation at temperatures at which the equi-axed metal is brittle.

10. The greater the amount of cold-work the less is the elongation at the temperature of working or at the temperature of maximum elongation on cooling.

11. The hardening effects of slight or moderate deformations are greater the smaller the initial grain size of the metal.

12. Reduction of area of a cold-worked metal is in general less than in the annealed state.

Conditions at Slip Planes

The properties of cold-worked metals and the phenomena of plastic deformation indicate that important changes may take place on the surfaces of slip during and after deformation. A number of propositions regarding the conditions at slip planes are herewith presented. For the purposes of this discussion, the term "slip plane strength" will be used to denote the resistance to motion along a slip plane after slip has started. "Crystal strength" means the shearing strength of the unbroken crystal on planes parallel to the slip plane under consideration; it is the resistance to motion on the slip plane, *before* slip starts.

(1) *Immediately after slip begins, the slip plane strength is less than the crystal strength.* In coarse-grained metals, slips are readily observed which have extended for a distance of several thousand atom diameters. In single crystals tested in tension the extent of the motion on individual slip planes is still greater. After slip has once started, therefore, the resistance to further motion on the same plane must, for a while, be less than the resistance to the starting of slip on a parallel plane and hence less than the original shearing strength of the crystal. When iron has been recently

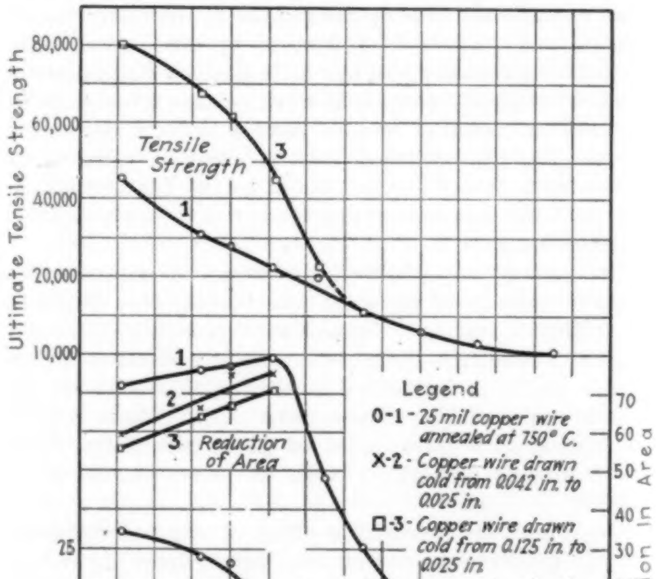
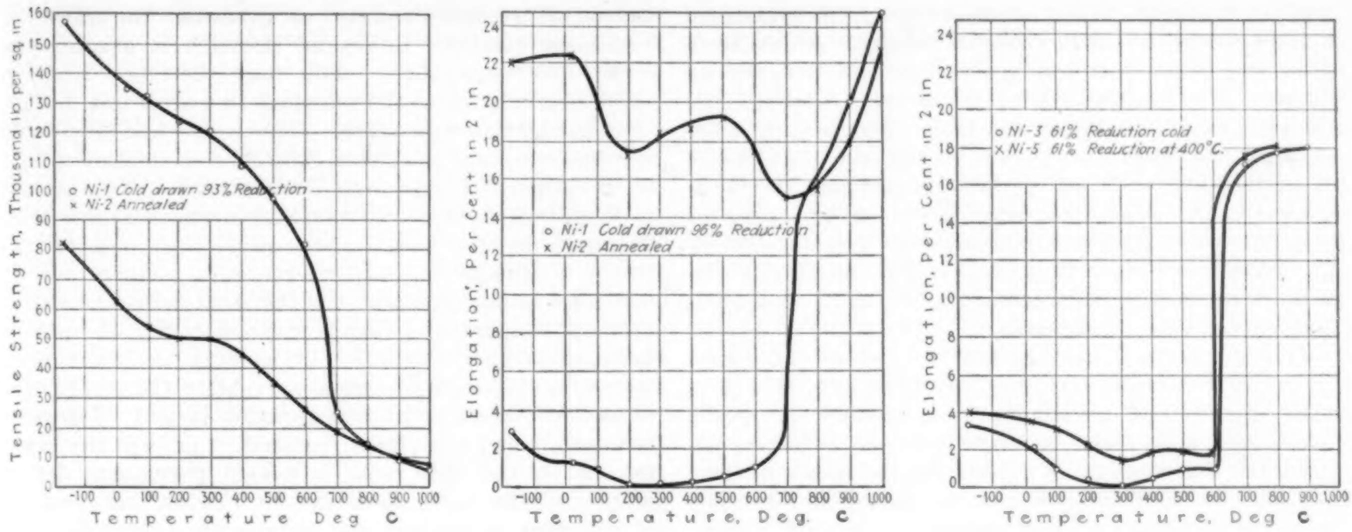


FIG. 1—TENSILE STRENGTH, ELONGATION AND REDUCTION OF AREA OF ANNEALED AND COLD-DRAWN COPPER WIRES AT VARIOUS TEMPERATURES. (JEFFRIES)



FIGS. 2, 3 AND 4—PROPERTIES OF NICKEL WIRE AT VARIOUS TEMPERATURES (SYKES)
Fig. 2—Tensile Strength Fig. 3—Elongation Fig. 4—Elongation, Cold- and Hot-Drawn

overstrained, the application of very small stresses results in permanent deformation which must take place by motion on the slip planes formed in the first overstraining process. Resistance to motion on these planes must, therefore, be quite low as compared with their original strength. The same is true of brass or other metals whose elastic limit is decreased by overstraining.

(2) *As slip continues, the slip plane strength increases to a value which may be greater than the crystal strength.* It is a striking fact that when single ductile crystals are tested in tension, failure does not occur on the first slip plane. Motion continues for a certain distance, after which further deformation takes place by slip on other planes. This means that the resistance to motion on the original slip plane must have increased to a value somewhat greater than the resistance to motion on parallel planes in the crystal. The process of slip may be termed "self-stopping."

(3) *In a metal composed of an aggregate of grains, slip is stopped partly by the interference of adjacent grains and partly by the resistance on the slip plane itself.* In a single crystal which is ductile it is necessary that motion continue on the first slip plane until the resistance to motion automatically becomes greater than that in the unbroken crystal. In an aggregate composed of many grains, however, motion on a slip plane in any one grain is opposed by adjacent grains through which there are no corresponding planes of weakness. Slip may there be brought to a halt by end resistance before sufficient motion has taken place to increase the resistance on the plane to the self-stopping point.

(4) *Slip planes in all stages of their history are present in cold-worked metals.* Since the slip plane strength increases with motion along the plane and since the extent of the motion on the various slip planes is different according to the various conditions of external support, it is evident that the resistance to motion on the various slip planes after deformation stops may be anything from the minimum to the maximum obtainable.

(5) *Slip causes rupture of the atomic bonds on the slip plane, and immediately after motion has stopped there is only partial re-establishment of cohesion.*

(6) *When the registry of the displaced crystal fragments permits, cohesion is re-established by the fragments joining into larger crystalline units.* The slip plane then disappears as such, being replaced by a *potential* slip plane whose strength is equal to the crystal strength.

(7) *As a rule, the crystal fragments do not register after deformation, and all degrees of disregistry occur.* It has been shown by X-ray analysis that new orientations are created by plastic deformation. Consequently there must be many, probably a large majority, of crystal fragments whose orientation does not permit them to unite except by the process of grain growth.

(8) *Re-establishment of cohesion between crystal fragments of different orientations must be attended with various degrees of disorganization as regards the arrangement of the atoms at the slip plane.*

(9) *This metal of partly disorganized structure simulates an amorphous material in its mechanical properties.* The characteristic properties of typical amorphous materials are first the great influence of time upon deformation, and second, the rapid change in properties with change in temperature. Cold-worked metals behave as though the resistance to motion on the slip planes varies in a similar manner with time and temperature. The slip plane strength increases on cooling and decreases on heating at a more rapid rate than does the crystal strength. For example, the tensile strength of cold-worked iron increases on cooling much more rapidly than the tensile strength of annealed iron.

(10) *Atomic rearrangement on slip planes takes place at temperatures much lower than are usually associated with recrystallization.* During the spontaneous aging of overstrained iron at ordinary temperature, or the rapid recovery of elasticity at a blue heat, the slip plane strength increases so that small stresses no longer produce permanent deformations. This increase in slip plane strength, or "healing" as we may call it, may consist in the growing together of fragments of sufficiently similar orientation, or in the establishment of cohesion at additional places on the planes between fragments that do not register. Rosenhain has observed that when a piece of iron is polished immediately after overstrain, lines are found which probably represent the intersection of the polished plane of the specimen with the surfaces of slip. These lines (called X-bands by Howe) are not found in the specimen if permitted to rest or recover before polishing. Lea has reported

that the recovery of iron or mild steel from overstrain is accompanied by an *increase* in density. All evidence is to the effect that the healing process involves an increase in the continuity of the metal. Although the electrical conductivity of metals is decreased by cold-working and is in general least when the metal is in its hardest condition, it is to be expected that the hardening of a cold-worked metal like iron by aging or heating at low temperatures would be accompanied by an *increase* in conductivity. Further heating would produce a continued increase in conductivity but eventually a decrease in hardness.

(11) *At certain temperatures slip planes may heal during deformation.* This is what happens at a blue heat in iron and at similar temperatures in nickel. When the slip plane strength exceeds the crystal strength, deformation is forced to take place on new slip planes. Spontaneous healing during deformation therefore results in a more intricate system of internal deformation.

(12) *On lowering the temperature, the slip plane strength may increase to a value greater than the crystal strength without any healing taking place.* For a given degree of disorganization at the slip plane and a given degree of re-establishment of cohesion, the ratio of slip plane strength to crystal strength is greater the lower the temperature. Slip may therefore reach a self-stopping state at low temperatures after less motion than at higher temperatures. This would lead to greater internal working by a given external deformation at low temperatures than at high temperatures. This excess of slip plane strength over crystal strength at low temperatures is the fundamental cause of the general increase in elongation with decrease in temperature of test, and in particular of the fact that wires drawn at certain temperatures until their ductility is nearly exhausted regain ductility on cooling to lower temperatures. Elongation takes place after the yield point is passed. Yield point is a function largely of *crystal* strength, being the stress required to deform the crystal. After the yield point is passed, permanent deformation of the metal continues as long as the strength is sufficient to sustain the deforming load. Rupture finally takes place at the slip planes. An increase in slip plane strength as compared with crystal strength therefore raises the tensile strength as compared with the yield point, and hence promotes elongation before rupture.

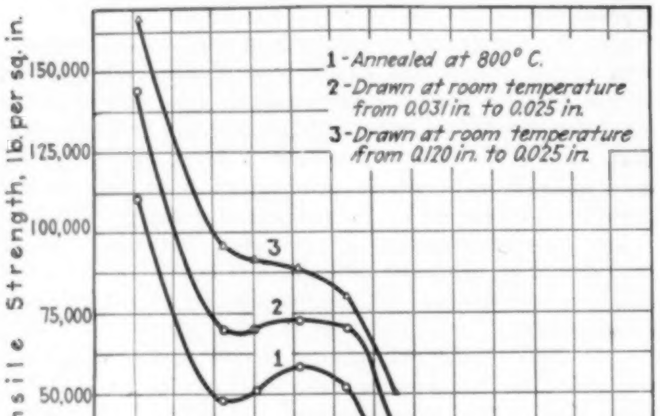


FIG. 5—TENSILE STRENGTH, ELONGATION AND REDUCTION OF AREA OF ANNEALED AND COLD-DRAWN ARMCO IRON WIRES AT VARIOUS TEMPERATURES. (JEFFRIES)

(13) *The properties of the disorganized metal at the slip planes probably never become those of the hypothetical vitreous amorphous metal which would prevent any further motion on the same planes during further plastic deformation.* This has been discussed more fully in a previous article,[5] in which it was pointed out that slip planes must be used repeatedly to account for the large amounts of plastic deformation that are possible.

Cause of Strain Hardening

The motion of crystal fragments on a number of intersecting systems of slip planes destroys the continuity of the planes of weakness. Slip in any crystal fragment is opposed by adjacent fragments in somewhat the same way that slip is opposed at grain boundaries. During the first stages of deformation the orientations of the fragments produced from any one grain are only slightly changed and the effectiveness of the support by adjacent fragments is not so great as at the grain boundaries. As the deformation progresses, some of the crystal fragments are rotated, as is shown by the fact that new orientations are found. The slip interference is then comparable to that at grain boundaries and the structure is comparable to a very fine-grained structure.

Since the resistance to motion along a slip plane may be greater than in the unbroken crystal, these slip planes are sources of strength and hardness aside from the slip interference action. In this respect it may be said that the creation of disorganized structures whose properties simulate those of an amorphous material is a cause of hardness in cold-worked metals. However, the importance of such amorphous metal in hardening seems to have been greatly exaggerated.

The hardening effect of deformation increases with the number of slips taking place. Since strain-hardness is to be attributed chiefly to the slip interference created by the relative displacement of crystal fragments, this hardening will be greater, in general, the larger the number of planes on which slip takes place. A given external deformation will, therefore, produce greater hardness the greater the number of slip planes

[5]"The Amorphous Metal Hypothesis," by Zay Jeffries and R. S. Archer, *Chem. & Met. Eng.*, vol. 25, p. 697 (Oct. 12, 1921).

produced or the greater the internal working of the metal. In accordance with this principle, deformation produces hardness more rapidly as the temperature is lowered, as the initial grain size is smaller, and finally when spontaneous healing takes place during deformation (as in the blue heat range in iron). Fettweiss[6] states in his summary that cold-working of iron, followed by heating at a blue heat, produces the same results as working at a blue heat. The principle just stated shows, however, that a given deformation effected at a blue heat must produce more hardening than the same deformation effected at room temperature and followed by heating to a blue heat. A knowledge of the mechanism of the blue heat phenomenon thus assists in correlating its various manifestations.

Some Typical Examples

The examples to be given include metals crystallizing with face-centered and body-centered cubic lattices. No extensive investigations have been reported on metals crystallizing with hexagonal lattices, but such information as is available indicates a tendency toward less plasticity, a narrower range of temperature within which they are plastic and a tendency toward greater brittleness of the individual crystals than in cubic metals. The mechanical properties of the hexagonal metals are, however, in harmony with the general rules put forth in this article.

The data from which the accompanying curves were plotted are the results of tests made on wire of 0.025 in. diameter. In each case the elongation was measured on a length of 2 in. Testing conditions were similar for the various metals. For testing at low temperatures, a bath of liquid air was used; for tests at 100 deg. C., boiling water; and at slightly higher temperatures, a bath of oil. At still higher temperatures specimens were heated in an electric tube furnace, an atmosphere of argon being used to protect the specimens from oxidation when this was necessary. No determinations were made of elastic limit or yield point.

In Fig. 1 are two curves showing the variation in the tensile strength of annealed and cold-drawn copper with changing temperature. The curve for the cold-drawn wire is discontinued above 330 deg. C., because in this range of temperature the wire anneals rapidly and becomes practically identical with the material represented in the other curve. Below the recrystallization temperature the strength of the cold-worked wire increases more rapidly than the strength of the annealed wire.

Fig. 1 also shows the effect of temperature on the elongation of annealed copper wire and of two samples of cold-drawn wire reduced different amounts by drawing. Again the elongation of the cold-worked metal varies with temperature in the same manner as that of the annealed metal. At the lower temperatures the elongation of the cold-drawn wire increases more rapidly than that of the annealed wire, and the indications are that at some very low temperature the elongation of the cold-drawn wire might be the greater. Results are not plotted for temperatures above 200 deg. C. for the cold-drawn wires. Annealed and cold-drawn copper wires are also compared as to reduction of area in Fig. 1. The effect of temperature on this property is seen to be in the same general direction for cold-drawn and annealed wires. Again, results are not plotted above the recrystallization temperature.

Fig. 2 shows the effect of temperature on the tensile strength of annealed and cold-drawn nickel wire and records the same general tendency of decrease in strength with increase in temperature noted for copper. There is a marked break in the curve at 200 to 300 deg. C. for the annealed wire. This has been discussed above and is believed to be due to spontaneous healing of slip planes during deformation. The same discontinuity is reflected in the curve for the cold-drawn wire, but is less apparent. Annealing is seen to take place rapidly at 600 to 800 deg. C.

Elongation-temperature curves for the same nickel wires are shown in Fig. 3. Below the temperature of recrystallization annealed wire appears to have a general tendency toward increased elongation with decreasing temperature. This general trend is broken at 200 to 400 deg., the minimum in elongation at 200 deg. C. corresponding with the horizontal portion in the tensile strength curve. A slight drop in elongation on cooling from room temperature to the temperature of liquid air is probably due to the beginning of low-temperature brittleness. No tests were made between room temperature and liquid air temperature, and it is quite likely that at some intermediate temperature the elongation would be higher than at any point shown on the curve. Elongation of cold-drawn wire increases continuously as it is cooled from 200 deg. C. down to the temperature of liquid air. The fact that no drop in elongation at low temperatures is shown corresponds with the general observation that cold-drawn metals remain ductile at lower temperatures than annealed metals. The rise in elongation in the cold-drawn wire above 400 deg. C. is due to annealing.

Fig. 4 shows elongation-temperature curves for nickel wires reduced the same amount at room temperature and at 400 deg. C. respectively. It will be noted that

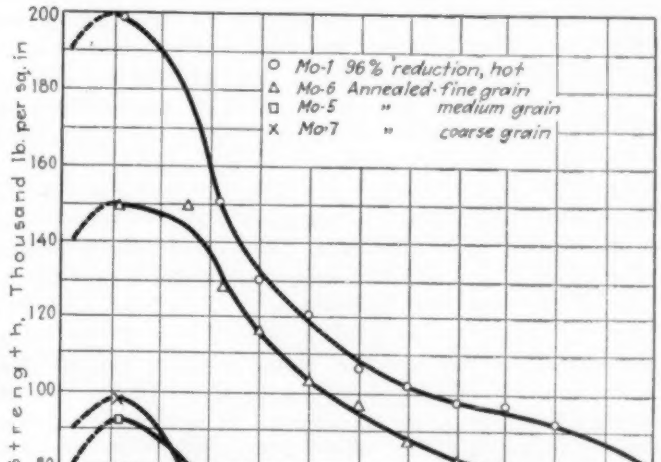


FIG. 6—TENSILE STRENGTH OF MOLYBDENUM WIRES AT VARIOUS TEMPERATURES (SYKES)

[6] "The Blue Brittleness and Aging of Iron," *Stahl und Eisen*, Jan. 2 and 9, 1919.

the elongation of the latter is higher, in accordance with the general rule that the effect of cold-work is greater the lower the temperature at which it is effected. These wires, which have been reduced less than the one represented in Fig. 3, show distinct minima in elongation at 300 deg. C., corresponding to the horizontal in the tensile strength curve for annealed nickel. In view of these curves it is probable that the minimum in elongation shown in Fig. 3 is also at least partly attributable to this blue heat phenomenon.

Fig. 5 shows the effect of temperature on the tensile strength of annealed and cold-drawn Armco iron wire. The strength increases with the amount of reduction by cold-drawing. There is a general decrease in tensile strength with increasing temperature, but annealed wire shows a very marked increase in strength on rising temperature, the strength reaching a maximum at about 200 deg. C. As pointed out above, the actual temperature of this maximum depends quite largely on the rate of testing. The same discontinuity is shown in the cold-drawn wires, but to a less marked extent. There is also a considerable increase in strength on raising the temperature of annealed wire between 850 and 930 deg. C., due to the allotropic change from alpha to gamma iron.

Elongation-temperature curves for annealed and cold-drawn iron wire are also shown in Fig. 5. Decrease in elongation of annealed wire at temperatures from 450 deg. C. upward is in accordance with the general law. A marked minimum in elongation at 100 deg. C. is due to the blue heat phenomenon. Below this temperature the elongation again rises in accordance with the general law to a maximum (which may be somewhat below room temperature), after which it decreases because of low-temperature brittleness. The cold-drawn wires also reflect the minimum in elongation in the blue heat range. Above about 450 deg. C. annealing takes place, after which the properties become similar to those of the annealed iron. There is no positive evidence here that the elongation of the cold-drawn wires would be greater than that of the annealed wire at very low temperatures, but such may be the case.

The same figure shows the effect of temperature on the reduction of area of annealed and cold-drawn iron wire. The general tendency is as usual—a rise in reduction of area with increasing temperature up to the recrystallization temperature, above which the reduction of area decreases. The minimum in reduction of area at about 330 deg. C. is again a manifestation of the blue heat phenomenon. It will be observed that the minima of elongation do not occur at the same temperatures nor at the same temperature as the maximum in the tensile strength, although the results are all from the same specimens. It is of interest that the cold-drawing has affected the reduction of area relatively less than the tensile strength and elongation.

Fig. 6 shows the effect of temperature on the tensile strength of annealed molybdenum wires of various grain sizes. (The wire described as reduced 96 per cent hot was produced by hot-swaging followed by drawing, part of the reduction at least being effected below the recrystallization temperature.) In all wires the tensile strength decreases with rising temperature throughout the range shown. In the annealed wires, particularly those of medium and coarse grain size, there is a marked horizontal extending from about 100 to 900 deg. C., which is approximately the recrystallization temperature of molybdenum. This may be a manifestation of the blue heat phenomenon. Although tests were not made below the temperature of liquid air, the strength is represented as decreasing at lower temperatures. This fall in tensile strength might be expected to occur at some temperature slightly lower than —185 deg. C., since the tensile strength of tungsten falls between 25 deg. C. and —185 deg. C. Curves have already been given and discussed showing the effect of temperature on the elongation of molybdenum, in Fig. 2 of an article entitled "Effect of Temperature, Pressure and Structure on the Mechanical Properties of Metal" (*Chem. & Met. Eng.*, vol. 27, No. 15 (Oct. 11, 1922).

Fig. 7 shows the effect of temperature on the tensile strength of two kinds of tungsten wire, of which No. 1 has a structure composed of unstrained but slightly elongated grains. Wire No. 2 was produced by swaging and drawing from 0.165 to 0.025 in. at temperatures gradually falling from 1,300 to 1,000 deg C. The temperatures covered by these curves are entirely below

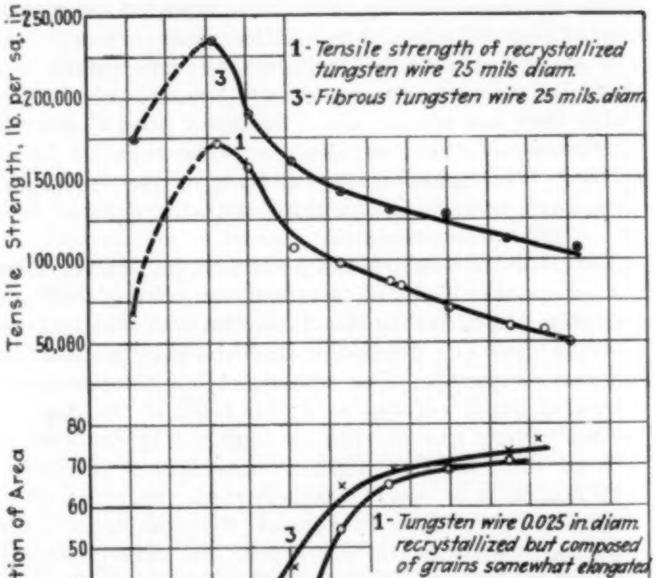


FIG. 7—TENSILE STRENGTH, ELONGATION AND REDUCTION IN AREA OF ANNEALED AND COLD-DRAWN TUNGSTEN WIRES AT VARIOUS TEMPERATURES. (JEFFRIES)

recrystallization. The tensile strength increases on falling temperature, but is lower at —185 deg. C. than at room temperature. Tungsten is the only metal in which this drop has been observed, but, as mentioned above, it probably occurs in most metals at some very low temperature. The actual hardness of the tungsten is probably greater in liquid air than at room temperature and the decrease in strength is probably due to brittleness.

Fig. 7 also shows the effect of temperature on the elongation of three kinds of tungsten wire as described in the figure. In all cases the the elongation increases on falling temperatures until the region of low-temperature brittleness is reached. These curves illustrate particularly well the law that the maximum elongation occurs at lower temperatures the greater the amount of cold-working, but that the actual elongation at this maximum decreases as the amount of working increases. Comparing the elongation and tensile strength curves, it will be noted that the development of brittleness is at first accompanied by a sharp rise in tensile strength. This appears to be a rule for all metals.

In both wires shown the reduction of area increases with rising temperature throughout the temperature range given. At all temperatures covered by these tests the reduction of area is greater in the cold-drawn wire than in the annealed wire.

Legal Notes

By Wellington Gustin

Notation in Receipt Regarding Disputed Shortage Not Sufficient Notice of Loss

An interesting point on shipping claims is had in an action by the Calumet & Hecla Mining Co. against the Delaware, Lackawanna & Western R.R. Co. and decided for the defendant by the Appellate Division of the New York Supreme Court. (190 N.Y.S., 410.)

The Calumet company claimed the right to recover from the railroad company the sum of $666.91, the value of 10 billets of copper, being a part of a shipment of 524 billets, shipped by it from its works at Lake Linden, Mich. The initial carrier was the Mineral Range R.R. Co. The freight was prepaid to New York City, consigned to plaintiff. The defendant, being the final and delivering carrier, duly gave notice of the arrival of the copper in New York. The plaintiff then directed the defendant to deliver the shipment, together with other copper, totaling 2,543 billets, to the steamship Orleans, of the Oriental Navigation Co., at the port of New York, for transportation to Bordeaux, France. Delivery was made 10 billets short.

Defendant gave to plaintiff the steamship receipts for the copper actually delivered, and received from the plaintiff in exchange therefor a receipt which plaintiff claimed constituted a notice of loss or damage which entitled plaintiff to recover. The receipt describes fully the copper actually delivered on board, and then contains the following statement respecting the 10 billets which had been lost:

"Ten (10) billets, mkd. C & H, more, in dispute. If on board to be delivered."

The sole question in the case to be determined was whether the above words contained in the receipt constitute a sufficient notice in writing within the meaning of the clause of the bill of lading following:

"Claims for loss, damage or delay must be made in writing to the carrier at the point of delivery, or at the point of origin, within 4 months after delivery of the property, or in case of failure to make delivery, then within 4 months after a reasonable time for delivery has elapsed. Unless claims are so made the carrier shall not be liable."

Claim Not Filed Within Specified Time

Within a few days of the receipt letters were written by both parties regarding the shortage, and 2 months thereafter the Calumet company was notified that the shipment checked 10 billets short on arrival at Bordeaux. Eleven months thereafter it filed its claim against defendant for the loss.

Notation Did Not Constitute Notice of Loss, Says the Court

The court says the receipt executed by plaintiff and the subsequent letters disclose that some dispute had arisen respecting the 10 billets of copper claimed to be missing from plaintiff's shipment. The defendant, evidently thinking there might have been a mistake in checking the copper, wished to take advantage of a rechecking when the ship reached Bordeaux. When the shipment was so rechecked at Bordeaux it became certain that the 10 billets of copper had not been found on board, and the plaintiff was so notified. However, it took no further step to notify the defendant until this belated notice of claim was filed, says the court. The receipt as mentioned above was not intended to operate as a notice under the bill of lading, the court said. The use of the words "in dispute" contained in the receipt, as above, showed clearly that neither of the parties regarded the notice as final, or that it had actually been determined that any loss or damage had been sustained. At most, it indicated only uncertainty as to whether the 10 billets of copper were included in the shipment. Such uncertainty was to be resolved when the goods came to be rechecked on arrival at Bordeaux.

The court says the defendant carrier had a right to expect further advices if, upon arrival there, it was found that the 10 billets were missing, and, if the plaintiff was to make claim for loss, that the defendant would receive timely written notice of such claim. Having failed to make such claim within 4 months after delivery of the property in question, reliance could not be had on the receipt, as it did not constitute even a substantial compliance with the requirements of the bill of lading.

Slide Rule for Furnace Calculations

A handy circular slide rule for calculating furnace additions has been designed by F. Wright and is being distributed by the Pittsburgh Electric Furnace Corporation. It contains six scales—viz., for the weight of the furnace charge, the points of alloy or carbon to be added, the percentage of that element in the ferro available, the per cent of absorption by the bath, the melting loss, and finally the pounds of ferro required. Normally the slide rule would be used to determine the pounds of addition required to bring the bath to a given analysis, although it may obviously serve to compute any unknown factor, given the other five.

Internal Mixers*

A Critical Study of the Limits of Application of the Internal Mixer to Rubber Compounding—The Chief Difficulties in Its Use Are Analyzed—Where Possible Corrections in Design Are Suggested and the Limits to Its Use Defined

BY R. P. DINSMORE
Chief Compounder, Goodyear Tire & Rubber Co.

IT IS intended to discuss the action of internal mixers (chiefly in comparison with mill mixing) on the basis of practical production experience in connection with various types of rubber compounds, especially tire stocks. Although most of our work was done on one type of mixer, sufficient data were obtained from other types to make our conclusions more or less general. Under internal mixers we may class all those which utilize a closed chamber to hold the charge or batch and which for mixing depend upon the action of a mixing mechanism which works the material back and forth laterally, longitudinally or both.

The internal mixer naturally appeals to the practical rubber man who has been accustomed to working his rubber on a mill by means of his hands and a knife and to putting his compound onto the rolls with a shovel, during which process he must inhale considerable dust and fumes. The idea of eliminating much of this labor and greatly reducing cost and fumes is attractive. Probably the advent of carbon black into the field of rubber compounding has done more than any other one thing to popularize the idea of internal mixing. Certain factors combined to make it more practicable to use the early design of internal mixer for mechanical goods stocks—that is, molded goods other than tires—rather than for tire stocks. Later improved designs and, as previously stated, the dirt nuisance from carbon black caused tire men to investigate its possibilities more carefully.

CLASSIFICATION OF RUBBER STOCKS

Before discussing the behavior of various types of stocks it may be well to make a general classification for reference purposes. The rubber manufacturer roughly classifies his stocks as high grade and low grade, not upon the basis of the degree of satisfaction with which they perform the required functions in the finished article, but chiefly according to rubber content. Under high-grade stocks, therefore, we may class most tire compound, balloon stocks, and a few mechanical goods and so-called master batches which are simply mixtures of individual compounding ingredients with rubber, designed to facilitate handling or increase the accuracy of weighing. Low-grade stocks include most mechanical goods compounds, a few tire stocks such as bead fillers and in this group we may also class accessories.

LOW-GRADE STOCKS CAN BE HANDLED IN INTERNAL MIXERS

Early experience with internal mixers showed that most low-grade stocks could be mixed successfully and many of them more economically than on a rubber mill. The reasons are fairly obvious in that where there is a great deal of dry filler compared to the amount of rubber present, and especially where softeners are used in considerable quantities, it is easier to keep the fillers in contact with the rubber and effect a mixture when the entire mass is inclosed and subjected to a stirring action than when the compound must be shoveled onto the mixing rolls. It is a matter of long experience in the rubber industry that many batches of this type can be best mixed on a mill by the addition of a great deal of softener and the use of a scraper to take the rubber off the rolls. In internal mixing much the same thing is done in a more efficient manner. It is true that if batches were made too soft they sometimes stuck in an internal mixer and made it difficult to clean out, but in general it may be said that low-grade stocks mixed fairly well.

In the initial stages of internal mixer development work was also done with master batches, particularly those containing carbon black, but sufficient trouble was experienced to prevent the old type of mixer becoming a serious competitor of the mill for this purpose, and in the case of carbon black, the bearings were attacked due to inability to pack them tightly enough to keep the black out.

Before we leave the early history of this type of mixer it may be well to state that it was found essential to take the large chunks of rubber stock coming from the mixer and pass them through mill rolls in order to sheet them out in a form which would be convenient for handling and storage and which would admit of sufficiently rapid cooling to prevent injury to the compound. This condition has remained constant throughout all subsequent developments. It was found that even with this expedient high-grade stocks other than master batches were very tough when mixed in this way and had a strong tendency to start premature vulcanization, or as we express it, to "scorch."

IMPROVED DESIGN OF INTERNAL MIXERS

In the last few years improved types of internal mixers have been put on the market with better mechanical design and better facilities for cooling. Bearings have been perfected, the machine in general strengthened, and the mixing mechanism as well as the chamber has been water-cooled and the method of emptying the mixer has been made much more simple and effective. It may be pointed out here that the internal mixer differs essentially from the mill in that much less batch surface, in proportion, is in contact with the cooling walls. This makes effective cooling difficult and hence cooling methods are highly important.

EXPERIMENTS WITH HIGH-GRADE STOCKS

In an endeavor to find out what this type of mixer could do, something over 1,000 experiments were made, chiefly on high-grade stocks which were grouped under two headings, one being master batches, which in no case contained sulphur; and the other group being tire stocks, which, of course, always contain sulphur and usually an organic accelerator.

In view of our past experience we expected our best results from high-grade stocks would be obtained in

*Revision of a paper presented at the Birmingham meeting of the American Chemical Society, April 5, 1922.

mixing carbon black into rubber, providing the bearings were properly designed. Work was therefore commenced on this basis.

For purposes of this study, a batch with the approximate composition of 35 volumes of carbon black and 100 of rubber was used. It was found impracticable to go to a higher concentration of black, and although lower concentrations were tried and equally good results obtained, no particular benefit was noticeable. Due to our experience in mill mixing, which showed that better results are obtained from mixing small-size batches, we began with a 60-kg. batch, which about half filled the mixer, and gave the rubber a separate mastication of from 2 to 5 minutes, adding the carbon black and mixing to a total time of from 8 to 20 minutes.

Initial temperatures averaged around 50 deg. C. and final temperatures about 95 deg. It was impossible to get a smooth mix, and the batch was dusty when dumped, showing an incomplete incorporation of the filler and the rubber. Batch weights were gradually increased to 75 and 100 kg. without any appreciable improvement. The temperature varied a great deal due to difficulty in regulating the water feed to the cooling chambers. This difficulty was finally overcome, but the tendency of the batch seemed to be to break up into lumps rather than to mix in a uniform mass. Longer working of the rubber before the black was added improved this condition to some extent; however, lumping continued to result, apparently from moisture taken from the rubber and condensed on the walls of the mixing chamber. It was finally found advisable to give the rubber a preliminary working or breaking down on the mill before putting it in the mixer. With this expedient better results were obtained, and after changing the batch weight we mixed as follows: Broken-down rubber was used and worked in the mixer for 5 minutes, then the compound was fed in very gradually until it was all assimilated, giving a total mixing time of 25 minutes. A 60-in. mill was required to batch off, the final temperature of the batch being 142 deg. C. This stock appeared to be uniformly mixed, no lumps were apparent, but it was noticeable that the glossy appearance characteristic of this batch when mixed on a mill was lacking.

Material mixed in this way gave a very satisfactory quality when tested in the various compounds employing carbon black, but continued production runs made with master batches processed in this manner established beyond question that these batches are tougher and do not work up as soft on a mill as the corresponding mill-mixed material.

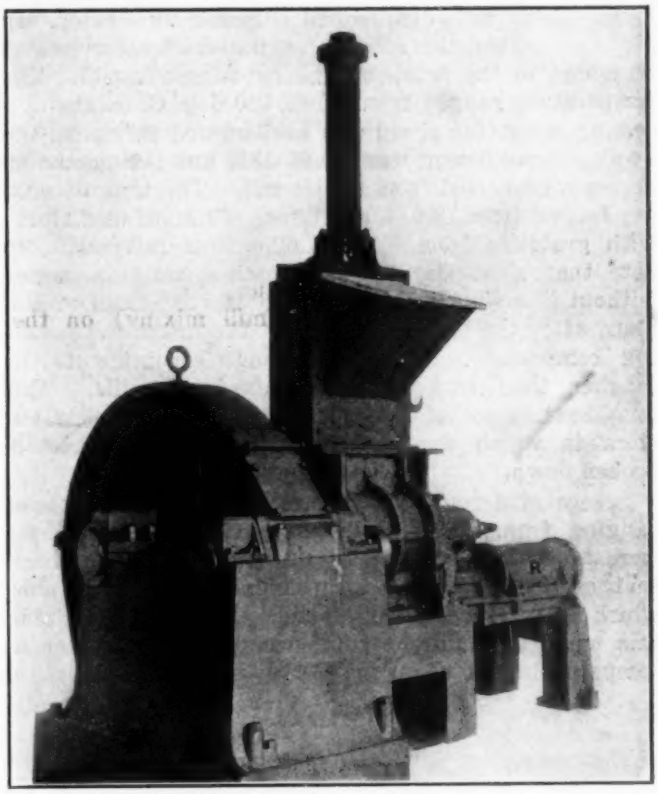


FIG. 2—BIRMINGHAM-BANBURY MIXER

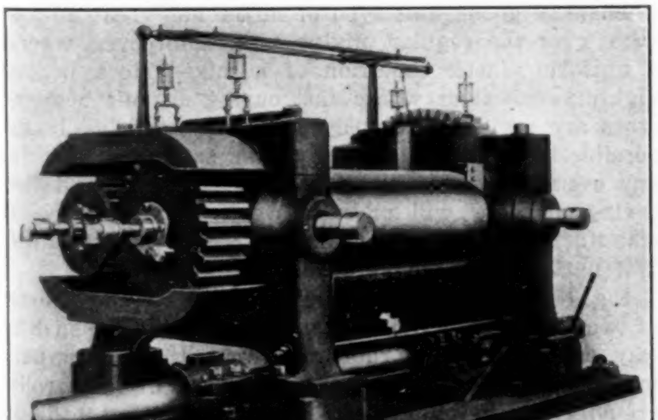


FIG. 1—STANDARD MIXING MILL

Facts which were established by this series of experiments were that the chamber of the machine must be nearly full to mix properly, the rubber must be dry and in a fairly plastic state before the addition of compound, and the compound must be introduced slowly, at a fairly uniform rate, so that the mixing mass maintains its continuity and does not break up into lumps. The distribution of compound was evidently fairly uniform as shown by physical tests on vulcanized stock, but the mixed batch was tougher than corresponding mill-mixed material. I might add that the rotor speed was 23 r.p.m.

Tire Stocks Could Not Be Completely Compounded in Internal Mixer

Attention was now turned to work on tire stocks containing sulphur and accelerator. It was considered desirable to study the effect of variation in speed, and this was done between a range of 18 and 30 r.p.m. of the rotor. It was found that for high-grade stocks increase in speed is accompanied by increase in heat generated, power consumption and slipping between the rotor and the stock.

The range of 21 to 23 r.p.m. was fixed as the most satisfactory for these stocks. For lower-grade stocks where softeners are used and there is less rubber, the speed may be increased to give a shorter mixing time with a much lower proportional increase in heat and power consumption. It was found that for any batch weight or speed which was established it was impossible to mix accelerator and sulphur into the batch in the internal mixer. Most batches permitted the mixture of sulphur at the very end of the mix, although in some

it was found advisable to add only the accelerator. In any case either the sulphur or the accelerator had to be added to the batch on the batching-out mill. The temperature ranged from 90 to 120 deg. C. on the outcoming stock, the speed was held around 20 r.p.m., the average horsepower was about 130, but the maximum horsepower varied from 175 to 275. The time of mixing ranged from 18 to 30 minutes. This included stocks with gravities from 1.0 to 1.62. It is interesting to note that although all these batches could be mixed without scorching by the addition of accelerator or sulphur, after the batch came out of the mixer the resulting compound was found without exception to be tougher than that regularly mixed on mills. This toughness is not of the nature of set-cured stock, but stock in which the rubber has not been sufficiently broken down.

Several different types of mechanical goods stocks, ranging from a cheap bumper stock to a black heel, were tried out and good results were obtained, except that even in these stocks toughness was noticeable, which was not ordinarily found. The time of mixing was much less and the batch weight much greater as compared to tire compounds.

Summary

This study on internal mixers has brought to light three inherent defects:

1. The ratio of cooling surface to volume of stock being less than for a mill batch and the rate of working being greater, heat is generated sufficiently fast to increase the temperatures considerably above those which are ordinarily obtained in mill work. This renders it impossible to mix an entire batch in the mixer without scorching.

2. The resulting mix, although uniform, is tougher than that obtained from a mill. This apparently is due to the fact that the mechanical action is different from that obtained with mill rolls. We have suspected for some time that rubber which is made plastic by heat differs from rubber which is made plastic by mechanical action. It is true that the softening of rubber by mechanical action is always accompanied by a certain amount of heat. Nevertheless, with proper cooling, the effect of mechanical action may be made to predominate. We have observed that rubber softened by heat alone, provided the temperature is not excessive, although apparently much softer when hot, eventually reverts to more nearly its original state than rubber softened by working on the mill. This phenomenon agrees very closely with that observed in connection with the internal mixer. We have already observed that the temperatures obtained are much higher, and it therefore seems logical to assume that the softening action which renders the mixing of the rubber and compound possible in an internal mixer is chiefly due to the heat generated. This is probably chiefly a decrease in the viscosity of the rubber without any great amount of depolymerization and hence we get reversion or toughness after the batch has cooled off.

3. An internal mixer is not a complete unit, but requires the use of a mill to slab off the mixed stock. It is difficult to balance up batching-off mill capacity with mixer capacity, due to the fact that the volumes of different batches vary somewhat and the treatment on the batching-off mill varies depending on the sulphur or accelerator which must be added at that point. Also, it is necessary to batch out stock immediately after it

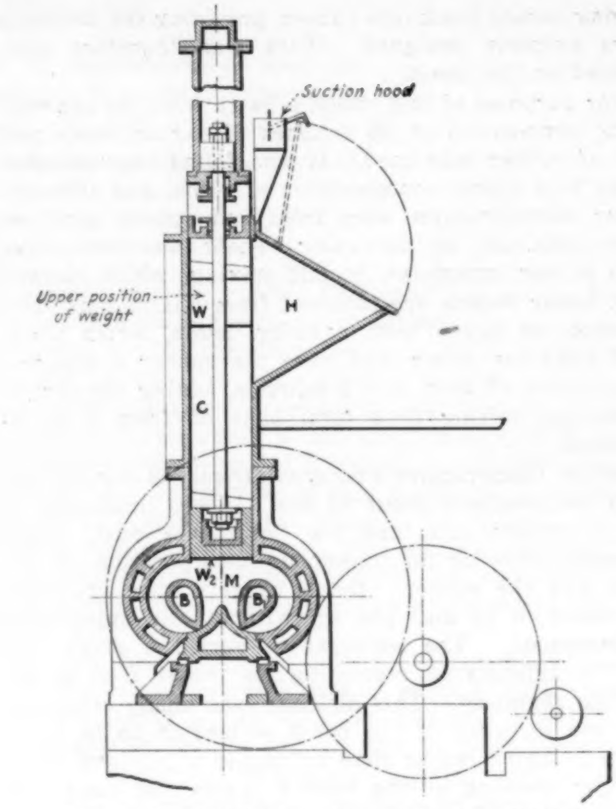


FIG. 3—DIAGRAMMATICAL CROSS-SECTION OF BIRMINGHAM-BANBURY MIXER

is taken from the mixer—particularly if the batch contains sulphur—because of the detrimental effect of the high temperature, which is maintained for a long period if the stock is left in large lumps. This means that the batch-out mills must be synchronized with the mixers. We have made a study of labor and power costs and believe it would be the most economical arrangement to erect a mixer on top of a suitable size mill with an integral drive. This arrangement would permit of dropping the charge directly into the mill rolls, would save trucking and insure rapid cooling of the charge after mixing.

In conclusion I will say that of the three defects mentioned, the first two appear to me to be inherent in the internal type of mixer, but of course the last can be readily remedied by design. I should like to point out that for certain type of stock, particularly mechanical goods, this type of mixer has great advantages over the regular mixing mill. Moreover, where a uniform plastic condition of a mixed stock is not highly essential or where fast curing organic accelerators are very little employed, it will undoubtedly be possible to handle high-grade stocks satisfactorily. In any event the reduction of the dust nuisance and the saving of labor will make it worth while for every manufacturer to study the mixer in connection with his own particular mixing problem.

Fig. 1 shows the standard mixing mill, which consists of two steel rolls driven in opposite directions in such a way as to draw the rubber between the rolls when inserted from above. The surface speeds of these rolls are slightly different, usually in a ratio of about 9 to 10. The rubber is sheeted around the slower roll and is cut back and forth with a knife until the right softness is attained. Then it is left running in such a way that a bank or roll of rubber is formed between the rolls, and fillers, sulphur, accelerators, etc., are added on top of

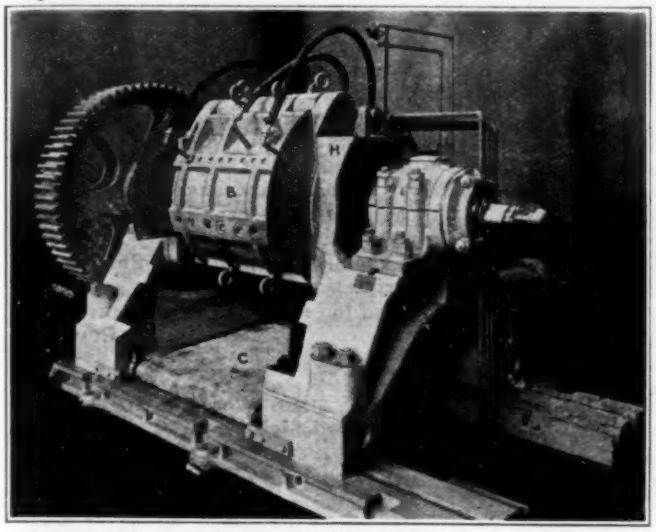


FIG. 4—FARREL MASTICATOR

the rubber, with a shovel. No cutting of the rubber is done during this stage of the mixing until all the filler is worked in.

Fig. 2 is a photograph of the Birmingham-Banbury mixer manufactured by the Birmingham Iron Foundry, Derby, Conn.

Fig. 3 shows a diagrammatical cross-section of the same machine. *H* is the hopper fitted with a cover and suction hood to take care of the dust. *W* is the weight which is raised by means of air piston to permit the introduction of the batch to be mixed through the hopper and cylinder *C* to the mixing chamber *M*. After the batch is introduced, the weight is lowered to the position W_2, thus forming an inclosed mixing box. The blades *B* revolve in such a way as to clean the walls of the chamber and work the batch back and forth. The blades and walls of the chamber are water-cooled. The batch is emptied by the operation of a hydraulic ram which displaces laterally the bottom plates of the mixing chamber, and permits the batch to fall down into a receptacle or onto a conveyor belt. The ram referred to is marked *R* in Fig. 2.

Fig. 4 is a masticator manufactured by the Farrel Foundry & Machine Co., Ansonia, Conn. The ingredients for the batch are introduced through the hopper *H*, which is duplicated by an exactly similar hopper at the other end of the machine. Material may thus be fed in from both ends. Inside the barrel of the machine *B* is a rotor, each half of which is in the form of a worm or screw. The direction of twist is such that the materials are forced toward the center from each end, causing a pile-up of material in the middle, which is relieved by the back-flow between the screw and the inside walls of of the chamber, thus giving an action which mixes and works the ingredients back and forth. The walls and screw of this machine are water-cooled. The batch is emptied by releasing a section of the mixing chamber, which permits the batch to fall on the conveyor belt *C*.

Aluminum Bronze for French Coins

Subsidiary coinage of aluminum bronze is to replace the paper notes now in circulation in France.[1] P. H. Gaston Durville, with M. Hanriot as chemist and principal assistant, have been working on the problem of new coinage alloys since 1909. They have succeeded in producing sound ingots of greenish-gold metal which conform to the several requirements of coinage metal: attractive; corrodes and tarnishes with difficulty and especially retains its color in sea air; forgeable, yet with sufficient difficulty to discourage counterfeiters; fairly hard.

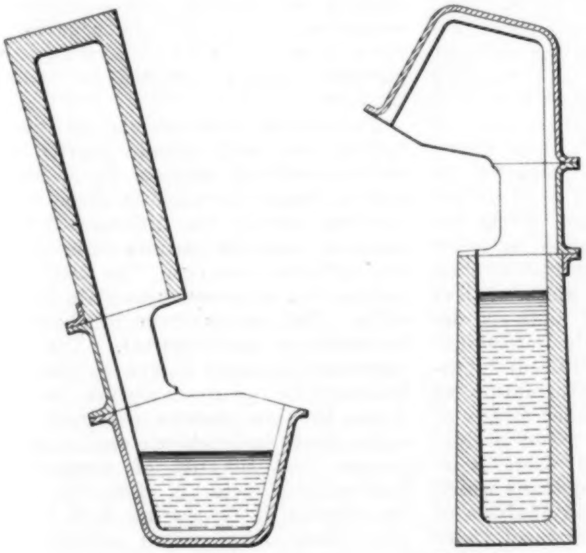


FIG. 1 FIG. 2

In manufacture, it was found very difficult to cast sound slabs, free of slag, gas bubbles or dirt. To overcome this, Durville has devised and patented a rotating, composite mold, diagrammed in Figs. 1 and 2. Crucible-melted alloy is skimmed and poured in the refractory-lined receiving basin as shown in Fig. 1. Immediately, and without the least jarring, the mold is rotated slowly into the position shown in Fig. 1. Four slabs, weighing 60 to 70 kg. each, are thus cast simultaneously; the pouring basin is removed and the slabs drawn as soon as they have solidified.

[1]*The Engineer*, July 21, 1922, p. 74.

Chilled-Iron Car Wheels

In view of the fact that the 5,000-lb. wheel loads of the freight car in use 50 years ago were carried on chilled-iron wheels weighing 525 lb., while today a similar wheel weighing 850 lb. is called upon to bear 25,000 lb., an investigation to determine the actual capacity of the wheel has been under way for several years, jointly under the auspices of the Association of Manufacturers of Chilled Car Wheels and the University of Illinois Engineering Experiment Station. Bulletin 129, by J. M. Snodgrass and F. H. Guldner, presents the first installment of their findings, on the strains in M.C.B. wheels due to pressing the wheel on the axle and due to static loads.

Tensile strength of specimens cut from wheel plates varied from 23,300 to 32,800 lb. per sq.in., and the modulus of elasticity from 14 to 28 million. These figures cannot be predicted by hardness tests.

Forcing the wheel on the axle stresses the wheel most highly in tension in a tangential direction at the bore. The outer face is stressed in compression in a radial direction. Brackets take no material load.

Static loads are transmitted from the hub to the rail mainly through the outer plate, and do not add greatly to the strains induced by mounting the wheel on the axle. It seems therefore that very great static loads may be safely carried by the present wheel.

Book Reviews

DICTIONNAIRE ANGLAIS-FRANÇAIS-ALLEMAND DE MOTS ET LOCUTIONS INTÉRESSANT LA PHYSIQUE ET LA CHIMIE. By *R. Cornubert*. xxxii + 297 pages. Paris: Dunod, Éditeur, 47, Quai des Grands-Augustins. Price, broché, 42 fr.; relié, 47 fr.

While a good technical dictionary is almost indispensable for any investigator who has to keep in touch with foreign literature, it is also true that the real usefulness of such a book is directly proportional to the ease with which it yields the desired information. Most three-language dictionaries are divided into three separate sections or even volumes, as English-French-German, French-German-English, German-English-French. By means of an ingenious arrangement, M. Cornubert has been able to combine these three into a single one with three parallel columns containing English, French and German words respectively. In each column the word whose translation is desired is set in black-face type while the equivalents appear on the same line in the other columns in ordinary type. With this procedure, a single alphabetical arrangement suffices for the three languages, as is evident from the following excerpt:

pilot burner	**veilleuse**	Sparflämmchen
vector	vecteur	**Vektor**
velocity	vitesse	Geschwindigkeit
loop	**ventre**	Bauch
to generalize	généraliser	**verallgemeinen**

An introductory section gives general data on German technical nomenclature, lists of English and German abbreviations and irregular verbs and of English units.

With its thorough treatment of technical terms in the fields of chemistry and physics and its rapid reference features, this dictionary should prove an invaluable aid to the busy technical man. ALAN G. WIKOFF.

ANALYSIS OF NON-FERROUS ALLOYS. By *Fred Ibbotson, D.Met., B.Sc., F.R.C., Sc.I., F.I.C.,* and *Leslie Aitchison, D.Met., B.Sc., A.I.C.* Second Edition. 246 pages. Longmans, Green and Co., London and New York, 1922. Price, $4 net.

As stated by the authors in preface to this second edition, they have added some new matter, consisting chiefly of methods for the analysis of light alloys of aluminum and of alloys of nickel. Otherwise the material presented has been reprinted without change from the first edition, issued in 1915. It includes chapters on apparatus for, and general description of, electrolytic analysis, on precipitation and comparative solubilities of the sulphides of the elements occurring in non-ferrous alloys and on methods of determination for these elements separately. The remaining chapters, occupying the smaller part of the volume, treat of methods specially applicable to commercial alloys. The general classes of non-ferrous alloys are covered by special methods for brass, bronze, phosphor tin, german silver, white metals, aluminum and nickel alloys and stellite. The added methods in this edition, besides those given for aluminum and nickel alloys, include methods for the separation of aluminum and zinc and for the determination of small amounts of elements which may be present in special brasses and bronzes. This new material comprises altogether about 22 pages.

The subject of analysis of non-ferrous alloys is probably covered more completely by this book, and by one other of American authorship, than by others published. However, in treating this subject it would be better if there could be given more detailed descriptions of methods of analysis for the various types of non-ferrous alloys and modifications required according to percentage composition. For instance, it would be well not only to give general methods for determination of white metal alloys but also to describe necessary details for applying the method to the separation and determination of tin in cable sheathing, where it is present to the extent of only 3 per cent, as well as in tin base-bearing metals, which may contain as much as 90 per cent and where it is necessary to separate tin from antimony and copper, as well as possibly from lead.

It should not be necessary to include in a treatise on this subject all of the important single methods of determination for each element, as this is the province of text-books on general quantitative analysis, but it would be desirable to include specific methods applicable to the separation and determination of elements present in particular alloys. The authors have described in the main part of the book most of the various methods for determination of separate elements, without in general stating which is preferable and without giving limits of accuracy. As an illustration of this, there is given under Antimony, as one of the gravimetric methods, a description of its determination as tetroxide, a method which is very seldom used. From the text one would not be able to learn where this method could be best applied or whether it might be more or less accurate than the other methods described. Under Volumetric Determination of Antimony four different methods are given without information as to probable accuracy or other means of judging which should be given preference. On the other hand, there is no mention made of certain methods which are very frequently used in analysis of alloys. For instance, under Lead, there is no description of its gravimetric determination as chromate, and under the analysis of White Metal Alloys no mention is made of a method which has been found generally useful and has been included in Standard Methods of the American Society for Testing Materials—namely, Thompson's method for alloys of lead, tin, antimony and copper, published in the *Journal* of the Society of Chemical Industry, 1896.

The style used by the authors in describing methods is a pleasing feature in that accurate descriptions of the operations to be followed are given without including explicit instructions as to capacity and shape of apparatus to be used, etc.—that is, directions are given so as to be perfectly intelligible to a chemist, without including detailed description of manipulation to be carried on by a laboratory assistant.

WILLIAM A. COWAN.

THE DETERMINATION OF SULPHUR IN IRON AND STEEL. By *H. B. Pulsifer*. Cloth, 9¼x6¼. 160 pages. The Chemical Publishing Co., Easton, Pa., 1922, Williams & Norgate, 14 Henrietta St., Covent Garden, W. C., London, England.

The author is to be congratulated upon his originality of publishing a book which covers but one element in iron and steel. He published his method for the determination of sulphur in iron and steel in the 1916 *Journal of Industrial and Engineering Chemistry*, vol. 8, p. 1115, in which a comprehensive list of the bibliography was published.

The present volume deals with the evolution method for determining sulphur in iron and steel, consisting essentially of using a strong solution of hydrochloric acid in a 500-c.c. flask containing a glass stopper which is water-cooled with a glass worm extending about one-third of the distance into the flask. The bibliography is very complete and covers references on the sulphur determination in iron and steel from 1797 to 1921. Illustrations are also given showing micrographs and sulphur prints of sulphide areas. The book is well written and contains descriptions of sulphur methods which have been published, including comparative results obtained by various methods.

The author recommends the use of hydrochloric acid, specific gravity 1.19, for determining sulphur by evolution, and on page 52 a table is given covering the use of six different sulphur methods and the results obtained on five different samples. The nitric acid method has a tendency to yield low results. This is also true of the dilute hydrochloric acid method. The least variation is shown in the concentrated hydrochloric acid evolution method. From the low results obtained when using dilute hydrochloric acid, it would appear that the use of concentrated hydrochloric acid is desirable. The importance of dispensing with rubber connections from which sulphur may be derived is dwelt upon. It is necessary to use a condenser when using concentrated hydrochloric acid, otherwise the acid will distill over and quickly neutralize the alkaline cadmium chloride solution.

On page 46 reference is made to the analytical results obtained with standard methods, and in each instance the

students found some sulphur in the iron. (An anomalous statement is made that the results may be a 100 per cent too high or 100 per cent too low. As there can be no more than 100 per cent, it is difficult to see how the results could be a 100 per cent too low, if the students obtained any sulphur whatever!)

Taken as a whole, the book is well edited, it covers the subject very fully and is recommended to those interested in the various methods for determining sulphur in iron and steel.

J. A. AUPPERLE.

THE ELECTROMETALLURGY OF STEEL. By *C. C. Gow*. 351 pages. New York: D. Van Nostrand Co. Price $7.50.

This recently published book gives the historical development of the electric furnace and considerable information on the electrical characteristics of the various types of furnace, a portion of the book being given up to highly theoretical electrical features of various furnaces. This possibly represents the author's chief interest. The matter relating to the metallurgical side of the problem is a summary of what has been covered in previous literature. The whole book presents no very striking advance in presenting known facts, but if one wishes an elementary survey of the general field it will be found in this volume, presented in very readable style.

FRANK HODSON.

Synopsis of Recent Chemical & Metallurgical Literature

Lead Baths

In a paper read before the Detroit meeting of the American Society for Steel Treating, R. B. Schenck, of the Buick Motor Co., described an extensive use of lead baths for hardening and tempering axle shafts, transmission gears and other parts. It is a heating medium which is easy to control, heats the work uniformly, and without chemical action of any sort. Great uniformity of results is therefore easily possible.

Lead baths can be operated at any temperature from 650 to 1,700 deg. F. Lead will never stick to the work if the surface of the bath is kept free from a floating scum of oxide. This is best accomplished by maintaining a thin protective coating of granular carbon—some material like charcoal, having a low kindling temperature, is best. If annealing or tempering baths tend to leave an adherent metal film on the work, the articles may be plunged, immediately upon withdrawal, into molten caustic soda at a slightly lower temperature, and then into cold water. A molten salt cover works all right on lead for a few days, but thereafter the whole mass tends to get mushy.

Cast iron pots can be used for baths operating below 1,300 deg. F.; cast steel gives better results for hotter work. If direct flames are not permitted to strike the pot, it will last for months —the principal corrosion being at the surface of the melt. Rectangular pots, hung from a lip at the top, are very satisfactory, especially if heated from below by a single flame traveling from one end to the other and then deflected back again by proper baffle walls and partition. Deep round pots should be rested on a brick pier, and heated by tangential, swirling flames.

One hundred and thirty-five pounds of work can be heated to 1,500 deg. F. per gallon of oil burned, or if the waste gases be used for warming a preheating pot, the figure can be doubled. Double handling of the work may cost more, however, than the oil saved. If kept well covered, lead consumption should not run over ½ lb. per 100 lb. steel treated. About 1¼ lb. of charcoal cover is burned per sq.ft. of surface per hour.

Refractories for Zinc Smelting

Requirements for refractories used in the zinc industry are considered by G. C. Stone, of the New Jersey Zinc Co., in the September *Journal* of the American Ceramic Society, p. 597.

In roasting furnaces of the Hegeler type, which are most extensively used, refractory trouble is caused by the furnace design. These furnaces are very large, about 80 ft. long, 17 ft. wide and 30 ft. high. Everything is in two parallel sections. Starting from the bottom each section has regenerative chambers, and above, three gas chambers, seven roasting hearths and frequently special air passages. The arches are both set on the center wall. The life of the furnaces is long, as there is but little corrosion or wear and the temperatures are not excessive, but the load acting on the center wall, which is maintained at a relatively high temperature, causes it to settle badly. This settling is very serious, as it is not uncommon to find the inner side of the hearths 5 in. lower than the outer, which interferes materially with the operation of the furnace. It should be possible to burn brick so that even long-continued heating to a temperature of about 850 deg. C. and never exceeding 900 deg. C. would not cause a shrinkage of from 1 to 3 per cent.

In zinc oxide furnaces the temperature is only about 1,000 deg. C., but the sudden changes caused by air cooling, when the furnaces are cleaned out and charged every 6 or 8 hours, and the rather severe handling in breaking up and removing the charge often damage the brick. Dense hard-burned brick are best.

Spelter furnace linings have to stand a high temperature for long periods with a regular daily variation between 800 and 1,400 deg. C. Practically the whole lining is made of special shapes, which are often made by the smelters themselves.

Retorts are also made by the smelters as they are placed in the furnaces red hot from the kilns in which they are burned. They should be capable of standing a temperature of 1,600 deg. C. without deflecting materially when supported only at the ends, with a clear span of about 4 ft. They must be dense, so as to be impervious to gases and zinc vapor, which tends to form zinc spinel.

Condensers are not subjected to temperatures above 600 deg. C., but they get rather rough handling as they are taken down and scraped each morning. They are also always made by the smelters.

Brick are often blamed for defects when the short life is due to poor brick-laying. From observation the author concludes that less than 5 per cent of the brick used are laid in a manner calculated to give the best results and fully half are badly laid.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Separating Gaseous Hydrocarbon Mixtures—The process is described with particular reference to the recovery of acetylene from mixtures with other hydrocarbons of relatively lesser solubility, but it is pointed out that other gases such as ethylene, propylene and the like can be similarly separated by a process of differential solubility. Practically complete separation is accomplished by solution at low temperature and high pressure with subsequent progressive increase in temperature and gradual elimination of the dissolved gases. By this means the gases first evolved from solution are returned to the solution chamber and the relatively soluble component which comes out of the solution last is separated from the balance almost pure.

Further development of this idea is presented in a second patent which discusses several variations of the basic idea. A still further development in a third patent relates more particularly to the separation of ethylene from mixtures with other hydrocarbons. (1,422,-182-183-184. George O. Curme, Jr., assignor to Union Carbide Co. July 11, 1922.)

Manufacture of Acetylene Products—The patent contemplates a process of producing products from acetylene by passing it, together with another reacting gas, over hydrated metal compound, oxide, bog-iron ore, or other iron compound with hydrated alumina or with an oxygen-yielding compound at temperatures ranging from 250 to 500 deg. C. The production of catalysts is also covered by the patent. These are the various oxides or hydrated metal compounds, either as first formed or in a partly reduced state, prepared by passing hydrogen or other moist reducing gas over the hydrated oxide at

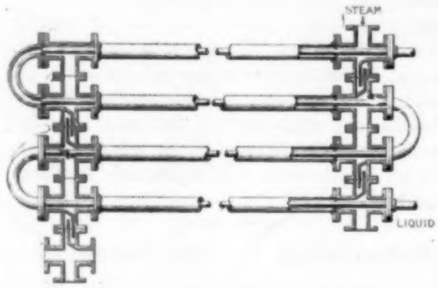
about 400 deg. C. The third group of claims covers the process for making compounds between acetylene and hydrogen sulphide by passing over appropriate catalysts at the temperatures named.

Five examples are given of typical applications of the patent. In the first, acetylene with four times its quantity of steam is passed over bog-iron ore at 400 to 420 deg. C., forming acetaldehyde as the chief product. It is claimed that 15 to 16 per cent of the acetylene is converted in a single pass. The second example relates to acetylene and a small amount of steam over partly reduced bog-iron ore for the production of the higher aldehydes, acetone, alcohol, acetic acid, furfurane derivatives, phenols, etc. The third example relates to acetylene and ammonia passed over bauxite at 350 to 380 deg. for production of nitriles and other nitrogen-containing bases to the extent of 50 per cent of the acetylene used. The fourth and fifth examples given relate to acetylene and hydrogen sulphide combinations used in contact with nickel hydroxide or bauxite for the production of thiophene, mercaptan, etc. (1,421,743. Bernhard Conrad Stuer and Walter Grob, assignors to the Chemical Foundation, Inc. July 4, 1922.)

Carbonaceous Product — This patent covers a product obtained by treating "rotted coal" with alkaline solution and the method of making the product. It is claimed that disintegrated coal treated with alkali produces a solution which would be useful as a fertilizer or as a raw material in the making of certain dyestuffs, etc. It is also suggested that a suspension of this rotted coal be used as a means for collection of ammonia from coal or coke-oven gas, the product being used as a fertilizer instead of ammonium sulphate. (1,420,754. Hugh Rodman, assignor to Rodman Chemical Co. June 27, 1922.)

Evaporator—This invention relates to evaporators; and it comprises an evaporator having tubular heating elements arranged in a vertical series with a substantially continuous evaporating tube passing through the several elements, the elements in each tier having a trapped liquid drain to the element below whereby to bypass condensed steam out of the path of heating vapors going through the series; and it more particularly comprises an evaporator of such a type wherein the trapped liquid drain is formed by co-operating and complementing unions, each said union having a flanged passage provided with a cuplike element having a portion extending beyond the flange plane and the elements being so shaped that on assemblage of two unions they together form a liquid-sealed trap.

In the well-known Kestner type of evaporator, evaporation is performed on what is termed a "climbing film"; liquid goes upward through a steam- or vapor-heated vertical tube, first as a sort of foam and finally as an annular ascending film with a central current of vapor traveling at a rather high velocity. For reasons of space it is sometimes desirable to use the same type of apparatus and operation in horizontal tubes rather than vertical; the evaporator tube being constituted of superimposed horizontal end-connected tube sections. In so doing, the surrounding heating element or jacket is likewise made as a series of superimposed sections connected together. In practice it is desirable that these jacket sections be rather narrow, giving a narrow annular pathway for the heating vapor or steam along the evaporator tube sections. The heating vapor flows through the system countercurrent to the liquid to be evaporated.



The difficulty with this construction is that condensed steam is apt to clog the long narrow pathway of the heating vapor at one point or another. Evaporators of this type have a high evaporative capacity with a concomitant absorption of heat, and the amount of condensate is considerable. It is necessary that the supply of steam or heating vapor be ample and that it flow through the heating elements with as little friction or interruption as may be from bodies of condensate. It is the object of the present invention to provide means whereby condensate in the heating elements may be bypassed downward from tier to tier out of the path of vapor in the narrow horizontal heating elements; the bypass connections being so arranged as to give a liquid seal to prevent flow of vapor. (1,424,254. Ralph Mellor, assignor to Kestner Evaporator Co., of Philadelphia, Pa. Aug. 1, 1922.)

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Titanium—Titanium dioxide is obtained from titaniferous bauxite by heating the finely powdered ore, preferably under a pressure of 3 to 4 atmospheres, with five parts of ammonium sulphate at a temperature of 350 to 400 deg. C. The iron and alumina present are converted into soluble double sulphates, with evolution of ammonia, the silica and titanium dioxide remaining unchanged. The product is treated with water, when the iron and aluminum salts pass into solution and the titanium dioxide forms a fine suspension. Silica and undecomposed ore are permitted to settle, and the suspension of titanium dioxide decanted off and filtered. Specification 15,590/06 is referred to. (Br. Pat. 181,775. E. E. Dutt and P. C. Dutt, London. Aug. 16, 1922.)

Artificial Filaments—A solution of starch or starchy matter in a large quantity of strong sulphuric acid and consisting of products intermediate between starch and glucose is used in the setting bath in the place of glucose in the manufacture of filaments, films, etc., from viscose as described in specification 21,405/07. Preferably, the moisture content of the starch, etc., is reduced to 5 per cent or less, and the dried starch is added rapidly and with continuous stirring to the acid which has been previously cooled to below 0 deg. C., for example to —5 deg. C.; after a homogeneous mixture has been obtained, the liquid is permitted to warm up spontaneously in order to complete the solution of the starch; before use, the mixture is diluted with water, and to the solution may be added sulphuric acid, sodium, ammonium or magnesium sulphate, or a zinc salt. (Br. Pat. 181,900. Courtaulds, Ltd., and M. T. Callimachi, London. Aug. 16, 1922.)

Phosphoric Esters—Mixed esters of phosphoric acid are prepared in known manner from parent materials which are either artificial mixtures of phenols containing at least 25 to 30 per cent of ortho- or meta-cresol, or the acid oils, either as a whole or single fractions therefrom, containing mixed monovalent phenols with at least 25 to 30 per cent of ortho- or meta-substituted homologs of phenol, which are produced in working up various tars, such as coke-oven tar or gas-works tar, low-temperature tar, mineral coal tar or brown coal generator tar. The method employed may be treatment with chlorine or oxygen compounds of phosphorus, such as phosphorus oxychloride or phosphoric anhydride; or the phosphoric di- and mono-chlorides from a single phenol or mixtures of phenols may first be prepared and then converted into the neutral esters. The products are slightly fluorescent viscous oils, useful as softening agents. (Br. Pat. 181,835. Chemische-Fabrik Griesheim-Elektron, Frankfurt-on-Main. Aug. 16, 1922.)

Phenol Condensation Products—The initial oily condensation product obtained by heating phenol with formaldehyde in the presence of sodium sulphite is mixed with a compound containing the CH_2OH or $CH.OH$ group and the mixture heated; the liquid product obtained may be converted into a hard infusible product by heating without pressure, or may be mixed with mineral fillers (clay, talc, mica, etc.), molded and heated to give products suitable for electric insulation or building purposes, or the liquid product dissolved in an organic solvent may be used for coating or impregnating paper or paper board, which is then hot-pressed and heated. Suitable hydroxy compounds are oxy-fatty acids such as glycollic, lactic, malic, tartaric or citric acid; alcohols, such as glycerol, butyl, amyl, ceryl, cetyl or myricyl alcohol, or cholesterol, or glucose, levulose, mannose, maltose, mannite, cane sugar, etc. (Br. Pat. 182,886. S. Satow, Tokyo. Sept. 6, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields
Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Chemical Foundation Files Formal Answer

Statement of William D. Guthrie, Counsel for the Chemical Foundation

THE CHEMICAL FOUNDATION has filed its answer to the suit of the government in Wilmington, Del. The answer is a comprehensive and emphatic denial of the government's charges. It denies that the Chemical Foundation participated in any conspiracy or monopoly or suppressed any information from the President or his representative, Assistant Secretary of State Frank L. Polk, or paid an inadequate consideration for the patents, or did any act in bad faith or unlawfully. The answer, on the contrary, points out that before any patents were sold to the Chemical Foundation every material fact bearing upon the creation of the Chemical Foundation, its objects, its work and its doings was discussed in the official report made to the President by A. Mitchell Palmer as Alien Property Custodian on Feb. 22, 1919, and transmitted by the President to Congress. An extract from this report is annexed to the answer as an exhibit. From this report it appears that the whole plan concerning the Chemical Foundation and its taking over of the German patents was disclosed in detail.

It is claimed in the answer, in addition, that not only were the President and Polk and Congress and the country generally advised of the plans which gave rise to the Chemical Foundation and the taking over by it of the German patents, but that Palmer as Alien Property Custodian also explained the situation personally to the President and to his representative, Frank L. Polk, and that after such report and such explanation, they made the orders authorizing and approving the sales which the present administration now challenges and seeks to nullify.

Seizure of Patents Defended

The answer points out that the taking over of the German patents was necessary to the proper prosecution of the war against Germany, for the common defense in case of renewal of hostilities or future war, and for the emancipation of the American chemical industry from German control and domination.

It narrates in detail how Germany had succeeded, by means of patents and otherwise, in obtaining complete control over the organic chemical industry of the United States. That meant that before the recent war Germany not only controlled the supply of dyes in the United States, but also that the materials out of which poison gas, high explosives and important medicines, like salvarsan, were entirely in the hands of the Germans. The answer insists that in such a situation the ability of the United States to manufacture high explosives and to defend itself according to the means and methods of modern warfare were at the mercy of Germany; that the ability of the United States to supply its citizens with important medicines was likewise at the mercy of Germany, and that many of its most important businesses were equally at the mercy of Germany. The report to the Alien Property Custodian, which was given to the President and which is annexed to the answer, shows how it was necessary to break this control of Germany over the chemical industry of the United States, if the United States was to have the power adequately to defend itself and protect its citizens.

Not a Private Venture

The President approved the policy of Americanizing the basic industries of the United States in order to overcome the German domination of those industries the answer points out. To that end the Chemical Foundation was formed, after conference with the President and his representative, Frank L. Polk, and with their approval, and after similar conference and approval, the patents in suit were transferred to the Chemical Foundation in order that it might hold and administer them in the interests of America and secure to the United States the permanent freedom of the organic chemical industry from German or other hostile foreign domination.

It further appears from the answer that on the President's return to this country, the orders made by Polk were brought to his attention and that the matter was again considered by him and that he thereupon made an order duly ratifying in all respects what had been done by Polk and the Alien Property Custodian.

The answer shows that the Chemical Foundation is not a private venture; that it has made and can make no profits for private persons; and that, on the contrary, it has expended thousands of dollars of its own capital to accomplish the public and patriotic purposes of President Wilson and its founders. Thus the Chemical Foundation is not like the ordinary owner of a patent, shutting out some persons from the use of it while giving others the right to use it as it sees fit. Under its charter and under its agreement with the Alien Property Custodian, the Chemical Foundation is required to and has and does license all American citizens who are qualified without discrimination and at equal rates and upon like terms.

The Chemical Foundation is also the means which was adopted to enable the United States to avoid having to pay heavy damages for patent infringements to Germans who had taken out patents of the United States, not in order to help American science and industry, but to throttle it. That was accomplished by having the patents sold to the Foundation and a release and license given by the Foundation to the government.

The answer concludes by praying that the complaint be dismissed.

Helium Production for Aircraft Will Soon Be Commercial

For the encouragement of the friends of lighter-than-air craft, Dr. R. B. Moore, chief chemist of the Bureau of Mines, who is in charge of the research work on helium being done jointly by the War and Navy Departments and the Bureau of Mines, declares the present situation is another instance in which it is darkest just before dawn. In Dr. Moore's opinion, the future of lighter-than-air craft never has been brighter. Experimentation in the cryogenic laboratory of the Bureau of Mines leads Dr. Moore to believe that within the next decade 99.9 per cent helium will be produced at a cost as low as \$20 per 1,000 cu.ft.

Thanks to the perseverence and unselfishness of the Linde Co. and certain scientists, the problems of helium production have been solved. All that remains to be done is to reduce the costs of production. Since American ingenuity has solved a hundred more difficult problems, Dr. Moore has every reason to believe that the production cost of helium will be reduced rapidly.

Once helium can be produced at a moderate cost, Dr. Moore expects to see the lighter-than-air ship take its place as one of the permanent agents of transportation.

University of Buffalo Inaugurates Capen

Dedication of New Chemical Laboratory Precedes Installation—Smith and Slosson Speakers

Samuel P. Capen of Washington, a member of the Society for Promotion of Engineering Education, has resigned as director of the American Council on Education to become chancelor of the University of Buffalo. He was installed Saturday, Oct. 28. The day preceding the inaugural, Foster Hall, the new $1,000,000 chemical laboratory of the University of Buffalo, was dedicated, the speakers being Edgar F. Smith of Philadelphia, president of the American Chemical Society, and Edwin E. Slosson of Science Service, Washington.

Special interest attaches to Dr. Capen's new position from the technical standpoint, because he is going to Buffalo for the avowed purpose of trying to carry into effect a system of "job analysis" for the professions that may pave the way toward elimination of useless frills in technical and academic education. Dr. Capen has been active in the educational relations of the National Research Council and during the war served on committees that aided the War Department in organizing the higher institutions of the country to make the most effective contribution to the war enterprise.

Dr. Capen was invited to become a member of the Society for Promotion of Engineering Education because of the excellence of the work he did while with the federal Bureau of Education, in evolving the technique by which the vital facts relating to the policies, financial administration and educational effectiveness of the institution being surveyed could be ascertained.

The New Laboratory

The new University of Buffalo laboratory is specially designed to meet the peculiar needs of the steel, dye, electrochemical and hydro-electric industries on the Niagara frontier and in western New York, which more and more are relying upon the university-trained man for important technical and administrative positions. The laboratory is not the largest, but it is believed to be the equal if not superior to any in the world. Many of the ideas of Prof. L. M. Dennis of Cornell, who for years has been studying the question of proper chemical laboratory construction, are embodied in the building.

One large room is so constructed that walls may be added or be torn out, according to the requirements of special work under way. The building includes a metallurgical, industrial, inorganic, organic, analytical, advanced analytical, miscroscopy and research laboratories, with private laboratories on a smaller scale for the professors.

The chemical laboratory is the gift of O. E. Foster, a Buffalo philanthropist, and is the first unit of the Greater University of Buffalo to be erected on the newly acquired 150-acre campus at the north end of the city, where an unusual educational experiment is to be carried on. Indicative of the backing the university has from the citizens of Buffalo is the fact that 2 years ago in an endowment fund campaign they contributed $5,000,000 in large and small amounts.

DR. SAMUEL P. CAPEN

Quebracho Forests in Danger of Extinction

The danger of the extinction of the quebracho forests of Argentina and Paraguay is imminent, according to H. M. Hoar, of the Research Division of the Department of Commerce. The total available tonnage of quebracho standing in 1922 has been liberally estimated at 71,300,000 metric tons for Argentina and 3,500,000 metric tons for Paraguay.

A minimum estimate of the potential production of quebracho extract by the companies now operating in Argentina and Paraguay is about 240,000 metric tons per annum, and as one ton of quebracho extract represents about 4½ tons of logs, it would require an annual felling of 1,400,000 metric tons of quebracho wood for tannin purposes alone in these two countries.

Add to this the annual cut for construction work, paving blocks, fuel, telegraph and telephone poles, for which quebracho wood is extensively used, also an estimated annual requirement of 3,600,000 railway sleepers, 1,600,000 fence posts and an annual exportation of quebracho logs, varying from 108,945 metric tons in 1917 to 56,582 in 1920, and the duration of the present stands of quebracho wood can be readily grasped, together with the necessity for forest protection and the restoration of denuded tracts.

Describes Methods of Organic Chemist

Prof. W. Lee Lewis, Retiring Chairman, Addresses Chicago Section, A.C.S.

To the layman the ways of all chemists are mysterious, but the organic chemist is frequently little understood even by fellow scientists whose work is confined to other branches of the subject. A decided step toward better mutual understanding was made Friday evening, Oct. 20, when Prof. W. Lee Lewis addressed the Chicago section of the American Chemical Society on "The Organic Chemist at Work." Taking as a typical problem the action of acetylene on arsenic trichloride in the presence of aluminum chloride, Dr. Lewis outlined step by step the methods of attack leading to the accumulation of sufficient data to enable large-scale production of a compound which because of its peculiar physiological properties was in demand at the time for military purposes.

Preliminary work on the reaction mixture having shown that the product consisted of a number of related compounds, one of which was more desirable than the others, studies were next conducted to determine the conditions which would give the greatest yield of this compound.

Following the main address were the group meetings which have become such a successful and helpful feature. The formality which is more or less inherent in a large gathering is not found in the smaller groups and this, together with the opportunity for more lively discussion, is very effective in increasing acquaintanceship among the members.

Laboratory Cost Accounting

Before the group on inorganic laboratory methods, A. W. Landstrom outlined a simple method of cost finding for a commercial laboratory. It was originally developed in order to determine whether the charges made for analyses were fair to both the customer and the laboratory, but was found so useful generally that it is kept up regularly. Time reports are made out for each analysis and from these the cost is determined as follows: The product of the number of hours and the analyst's rate per hour gives the direct cost. Fixed charges or overhead, and cost of materials and equipment for a year are divided by the number of man-hours per year to give the indirect cost on a man-hour basis. This is simpler than trying to figure the cost of materials, etc., for each type of analysis. The indirect cost is then the time multiplied by the man-hour factor, and this plus the direct cost gives the total. This system requires very little time and so costs practically nothing.

Topics at the other group meetings were: "Research Problems of the Baking Chemist," C. B. Monson; "1:4 Addition," C. D. Lowry; The Wassermann Reaction With Syphilis and Its Interpretation," J. J. Moore.

Tariff Commission Reorganized to Conform With New Rules of Procedure

Provision for Rate Changes Places New Responsibilities on Commission Which Will Be Met by Modified Organization

THE RULES of procedure under which the United States Tariff Commission will apply its enlarged powers were made public Oct. 26. On the same date William S. Culbertson, vice-chairman of the commission, in the course of an address before the American Manufacturers' Export Association, revealed the details of the reorganization of the commission to meet its new requirements. In that connection he said:

"The law provides that all investigations under Section 315 are to be made by the United States Tariff Commission and that the President shall issue no proclamation changing rates or classification until after the Tariff Commission shall have investigated. The commission has, as a result of these new responsibilities, completely reshaped its organization. Under the commission there are now four broad divisions: (*a*) The office of the chief investigator, (*b*) the office of the chief economist, (*c*) the legal division, (*d*) the secretary.

Detail of Organization

"The secretary handles the routine business of the commission. To the legal division are referred questions of customs laws and procedure and any other legal question that may arise in the commission's work. General investigations which the commission may conduct under its general investigational powers will be supervised by the chief economist, and special investigations made necessary by the new powers vested in the President will be under the direction of the chief investigator.

"The commission's organization under the direction of the chief economist and the chief investigator consists of a series of divisions each with a chief and other experts. These divisions are: chemicals, pottery and glass, metals, wood and paper, sugar, agriculture, textiles, leather, sundries, preferential tariffs and commercial treaties, and accounting. In addition, the commission has provided for the establishment of a New York office.

"The work of the commission's staff is co-ordinated in an advisory board which reports only to the commission and is under its immediate direction. The chief investigator is chairman of this board. Its other members are the chief economist, a representative of the legal division and the chief of the division of the commission concerned in the subject matter under consideration.

New Rules of Procedure

With regard to the new rules of procedure Mr. Culbertson said: "The first step in defining the commission's procedure was the issue on Oct. 7 of an executive order by the President directing that all applications for investigation under the new provisions "be filed with or referred to the United States Tariff Commission for consideration and for such investigation as shall be in accordance with law and the public interest, under rules and regulations to be prescribed by such commission."

"Today the commission gives publicity to its rules of procedure. They set forth how applications for investigations shall be made and under what conditions and in what manner the commission will conduct formal investigations upon which the President may change the tariff law. Anyone can apply for an investigation. The application need not be in any special form, but it must be in writing and signed by or on behalf of the applicant. It must also recite the relief sought and the reasons therefor. Obviously, the mere filing of an application does not obligate us to proceed formally. We shall not order an investigation unless the application or a preliminary investigation discloses to our satisfaction that there are good and sufficient reasons for doing so under the law.

"We can order a formal investigation upon our own initiative as well as upon application and we are not confined to the issues presented in an application; we may broaden, narrow or modify the issues to be determined.

Plan for Hearings

"When we finally decide to proceed formally with an investigation, we shall issue and publish a notice of its nature and scope. Any person who then can show to our satisfaction an interest in the subject matter of the investigation may enter his appearance in person or by a representative. He will be notified of public hearings and afforded opportunity to offer such testimony as we may deem necessary for a full presentation of the facts. Our hearings will usually be open to the public. Evidence submitted will be subject to verification from the books and records of the parties in interest. In conjunction with hearings we shall conduct field investigations both in the United States and in foreign countries.

"In the case of formal investigations our procedure will be judicial in character. Our rules provide for the attendance and examination of witnesses, the production of documentary evidence, the issuance of subpœnas and the taking of depositions. The commissioner or investigator in charge of any investigation will summarize the hearings and the information obtained by field investigation and will prepare a report. Parties of record will be permitted, before they file their briefs, to examine this report, as well as the record, except such portions as relate to trade secrets and processes.

"Final hearings will, of course, be before the commission. Parties of record may file briefs and in some cases present oral arguments. Our findings will be in writing, and will be transmitted with the record to the President for his action."

Muscle Shoals Report to Be Given Publicity

Senate Committee on Agriculture to Circulate Majority Findings

The printed record of the Muscle Shoals hearing conducted by the Senate Committee on Agriculture and Forestry during the last session of Congress is to be widely distributed. It is pointed out that it is important that those who mold public opinion which controls legislative action should know the facts concerning matters of this character. Accompanying the record will be the following letter signed by George W. Norris, of Nebraska, the chairman of the committee:

So much misinformation has been published and propaganda spread over the country by real estate boosters and others personally interested, that many good citizens, farmers, farmers' organizations and commercial and civic bodies have urged Congress to accept without qualification the offer of Henry Ford to take over for 100 years the war-built nitrate plants and appurtenances at Muscle Shoals, in Alabama, which cost \$90,000,000, and the uncompleted water-power dam on the Tennessee River in which the government has invested \$17,000,000, in all about \$107,000,000.

Contrary to a general idea, Mr. Ford does not agree to reduce the price of fertilizer one-half, one-third or even at all, although he stipulates he must have 8 per cent profit on the cost, whatever that may be; he does not agree to reimburse the government the additional \$50,000,000 to \$60,000,000 required to carry out his proposed contract, nor does he in fact agree to pay 4 per cent interest thereon for a lease for 100 years of the power dams and electrical equipment. For \$5,000,000 he acquires public property worth many times that amount, and exclusive use and control for 100 years of immense water power developed at government expense for about 2¾ per cent annual interest on the cost thereof, free of regulation, restriction or control by any public authority. He is exempt from the terms and provisions of the national water-power law passed 2 years ago to protect and conserve the interest of the public in the water-power resources of the nation, without obligation that any portion will be used by municipalities or industries in the South, but admittedly for the sole use of Mr. Ford in his own plants and his successors. He does not pledge his personal fortune or estate to the faithful performance of any obligation assumed by the corporation he will organize. He does not agree to repay the government all future outlays for repairs and maintenance, and whatever alleged public benefit proposed is not in any sense commensurate with the special and unusual privileges sought for one individual or corporation.

Whether the Muscle Shoals project is controlled or operated by the government or by private or quasi-private concerns, the public interest in a great navigable river and the water power that follows the improvement of navigation, as well as the products of plants constructed with public funds, should be conserved, used and distributed for the common welfare.

It is pointed out that the public should be informed of the facts in this matter, for its own protection, and should understand that the majority report was submitted after weeks of thorough investigation and taking of a mass of expert testimony.

Formula Is Devised for American Valuation

Customs Division Calculation Sounds Like Recipe for Home Brew

The customs division of the Treasury Department has devised and issued to collectors a formula for determining United States value as defined in the tariff act of 1922 and which is to be the basis of assessing duties on non-competitive coal-tar products in contra-distinction to American valuation which is to be applied to duties on competitive coal-tar products.

Subdivision D of Section 402 of the new tariff act reads: "The United States value of imported merchandise shall be the price at which such or similar imported merchandise is freely offered for sale, packed ready for delivery, in the principal market of the United States to all purchasers, at the time of exportation of the imported merchandise, in the usual wholesale quantities and in the ordinary course of trade, with allowance made for duty, cost of transportation and insurance, and other necessary expenses from the place of shipment to the place of delivery, a commission not exceeding 6 per cent, if any has been paid or contracted to be paid on goods secured otherwise than by purchase, or profits not to exceed 8 per cent and a reasonable allowance for general expense, not to exceed 8 per cent on purchased goods."

Valuation of Coal-Tar Products

In interpreting this, the customs division has instructed collectors to ascertain the dutiable value by taking the selling price in the United States, dividing by 108, subtracting the quotient from the selling price, then dividing this remainder by 108 in the case of purchased goods or by 106 in the case of goods where that commission has been charged, subtracting this second quotient and from this remainder subtracting the transportation and insurance charges and the specific duty. The final remainder, divided by 100 plus the ad valorem duty, which in the case of finished coal-tar products is 60 per cent, gives the dutiable value, according to this formula.

Some importers have insisted that the proper way would be to divide immediately by 116, rather than have two operations. This would lower the duty somewhat.

Feldspar Producers Recognize Need of Trade Association

Inability on the part of a considerable number of the feldspar producers and grinders to be present at a meeting held at the Bureau of Mines Oct. 25 made it impossible to carry through at that meeting the plan to organize a national association within the industry. It was felt by those present that the action should not be taken until the industry could be more generally represented.

Another effort to obtain the attendance of a representative number of those interested in the industry will be made at the coming meeting of the United States Potters' Association. At that meeting it is hoped to perfect plans for the organization.

The discussion among those who attended the meeting in Washington indicated a determination to have a national organization. It was pointed out that the feldspar industry is unique in that no other industry with as much capital invested is denying itself the benefits of the constructive functions which trade associations perform.

New Laboratory at Yale to Be Dedicated

Ceremony Will Be Feature of Spring A.C.S. Meeting at New Haven

The dedication of the new Sterling Chemical Laboratory of Yale University on April 4, 1923, will be a feature of the spring meeting of the American Chemical Society at New Haven. This arrangement has just been completed by national officers of the society and officials of the Yale Corporation. The dedication ceremony, with probably 1,500 or 2,000 members of the American Chemical Society in attendance, as well as the Yale faculty and student body, probably will be one of the most impressive affairs of its kind ever held.

The new building is one of the finest in the world and is built on an entirely new architectural principle. The main building is constructed on three sides of a square, three stories high and is in harmony with other buildings on the campus. In this building are class and lecture rooms, private laboratories and offices. Inclosed in the square is a one-story, saw-tooth roof type of factory building, with movable partitions. This structure can be changed to suit the various needs of the teaching staff. It is constructed to give the maximum of light and air and equipped so that it can be converted into several small workshops or one large shop, equal in size to a small commercial chemical plant.

Committee Chairmen

The following are chairman of the several committees for the meeting: Program, T. B. Johnson; finance, J. S. Gravely; dedication, John Johnston; registration, Blair Saxton; arrangement, A. J. Hill; hotels and transportation, Ralph Langley; smoker, P. T. Walden; reception and entertainment, C. H. Matthewson; publicity, W. T. Read; ladies' entertainment, Mrs. John Johnston.

The Chi chapter of Alpha Chi Sigma is to have charge of the information service of the meeting. Headquarters are Room 157 Sterling Chemical Laboratory, New Haven, Conn.

The scientific meeting will be under the auspices of the New Haven and Connecticut Valley sections of the society. Prof. Treat B. Johnson of Yale is chairman of the executive committee in charge, chosen from members of the two sections.

Seventy Million Yearly for Research

Chamber of Commerce Report Points Out Value and Place of Trade Associations

American industry is spending about $70,000,000 annually on scientific research, according to the Fabricated Production Department of the Chamber of Commerce of the United States. About one-half of this sum is spent by American manufacturers in the conduct of laboratory research, while the remainder is expended in experimental and development work in plants. As a result of scientific research work approximately one-half billion dollars is being saved annually by industry in this country.

"The value of scientific research, both from an economic and industrial standpoint," the department says, "has never been so fully appreciated as at the present time. The problems of the recent war forced science and its research activities to the front in all civilized countries. It is now realized by leading manufacturers that scientific investigation is a necessary adjunct to efficient co-operation. A utilization of the scientific knowledge now available and a sympathetic co-operation in the free interchange of such information will lead to the adoption of improved manufacturing processes and do much to obviate the danger of ignorant, destructive competition. The realization of this fact is shown by the 500 or more firms now maintaining laboratories for industrial research.

Trade Associations Correlate Work

"If there were no correlation of effort on research work, much duplication might result. The logical solution, therefore, is to have the trade association make this correlation. This enables a pooling of resources to maintain a central laboratory to render service to a larger group than is possible with only individual laboratories. Another and very important factor, especially valuable in strengthening trade associations, is that such centralized research work makes it possible for the small manufacturer, financially unable to support an individual laboratory, to profit from the investigations.

"It is not surprising, therefore, that a continually increasing number of trade associations are realizing the value of research as one of their most constructive activities. Of the sixty-five to seventy associations now engaged in this work to whom a recent inquiry was sent by the Fabricated Production Department, thirty-three gave specific replies, indicating that eight were conducting their research independently, and twenty-five were acting in co-operation with some other agency. The general leaning is toward the scientific aspect of research work. Nineteen trade associations are engaged exclusively in that class, three in the general problem class, while eleven give attention to both types of problems."

To Compile Import Statistics on Dyes

Government Will Keep Manufacturers Informed on Prices

So that domestic chemical manufacturers may be advised promptly as to the exact character of imports, the Chemical Commodity Division of the Department of Commerce will compile each month detailed information as to the imports of synthetic organic chemicals. The report will be mimeographed and a limited distribution of it made in that form.

Now that the selective embargo has been removed, manufacturers have indicated great interest in the prevailing current prices on important and typical products of foreign chemical industries. The Department of Commerce is arranging with its representatives in chemical centers for a cable service which will quote the actual prices at which these chemical products are being sold (not the prices at which they are offered). It is the intention to publish price information in mimeographed form for distribution to the trade.

The articles on which the prices are most desired are: Dyes—acid black, auramine, bismarck brown, direct black, fast light yellow, indanthrene blue, indanthrene violet, indigo, methyl violet, patent blue, rhodamine B conc., sulphur black, sulphur blue, wool green; intermediates — aniline oil, benzaldehyde, benzidine, betanaphthol, H acid, acetanilid, aspirin, choral hydrate, gallic acid, metol.

Personal

O. OTIS BOWMAN, 2ND, has resigned his connection with the Trenton Fire Clay & Porcelain Co., with which he has been associated for a number of years, to devote his entire time to the Bowman Coal Co., Trenton, N. J., of which he is secretary and treasurer.

Dr. T. R. DUGGAN will be the guest of honor at a dinner to be held at the Chemists' Club, New York, Friday, Nov. 3. Dr. Duggan, a former trustee of the club and chairman of the house committee, leaves for England shortly.

ALFRED D. FLINN has been elected director of the Engineering Foundation which is fostering organized industrial research on a nationwide scale. Mr. Flinn is the first incumbent of the new post, created by the Foundation's governing board, composed of the four founder societies of civil, mining, mechanical and electrical engineers, to meet the expanding activities of the Foundation. Mr. Flinn will retire as chairman of the Engineering Division of the National Research Council, a position which he has held since October, 1921, but will continue as secretary of the United Engineering Society in order that the Foundation may continue intimate relations with the founder societies. Mr. Flinn has been secretary of this society and the Foundation since January, 1918, and is widely known by engineers throughout the country.

LOUIS J. GUREVICH, formerly with the Hydraulic Steel Co., Cleveland, Ohio, is now metallurgist for the Owens Bottle Co., Toledo, Ohio.

Dr. H. J. HAMBURGER, professor of physiology, University of Groningen, Holland, addressed the Washington Academy of Sciences, Biological Society of Washington and the Chemical Society of Washington (D. C.) on Oct. 19. His address was on "The Increasing Significance of Chemistry in Medical Thought and Practice."

F. E. HAMER, editor of *Chemical Age*, London, who came here as a representative of Benn Bros, Ltd., to the meetings of the Associated Business Papers, Inc., and the National Conference of Business Paper Editors, sailed for home on the Baltic, Oct. 28.

Dr. ELLWOOD HENDRICK spoke at the opening meeting of the Baltimore Section of the American Chemical Society at the Engineers' Club, Friday, Oct. 27, on "The Vision of Science."

E. E. HUNT, of Springfield, Ohio, has been selected as the secretary of the President's Coal Commission. Mr. Hunt has been in charge of the study of intermittency in the coal industry, which the Department of Commerce has been pursuing since last March. For the purposes of that study a contribution was made from the Cabot fund. The study was an outcome of the unemployment conference, of which Mr. Hunt was secretary. Mr. Hunt had been associated with Mr. Hoover throughout the preparation of the report on waste in industry.

DORSEY A. LYON, chief metallurgist of the Bureau of Mines, is at the Minneapolis experiment station supervising test runs on the new blast furnace.

PROF. EMMANUEL DE MARGERIE of the University of Strassburg, French exchange professor in applied science and engineering, has arrived in America to take up work at seven leading engineering schools. The lectures begin at Columbia University.

Dr. C. E. K. MEES, director of the research laboratory, Eastman Kodak Co., Rochester, will give an illustrated lecture entitled "Chemistry and the Motion Picture" before the Society of Engineers at Troy, N. Y., Nov. 14, the Detroit Section of the American Chemical Society on Nov. 15, the Purdue Section of the American Chemical Society at Lafayette, Ind., Nov. 16, and the Chicago Section of the American Chemical Society on Nov. 17.

FREDERICK STUGARD, formerly chief chemist and superintendent of the Kosmos Portland Cement Co., of Louisville, Ky., has accepted a position with the National Cement Co. of Birmingham, Ala., as chief chemist at its plant at Ragland, Ala. He was connected with the Kosmos Portland Cement Co. from the day it started production in 1905, and served in various capacities as assistant chemist, chief chemist, assistant superintendent and superintendent during the course of his employment at the plant at Kosmosdale, Ky.

Obituary

Dr. RALPH R. POTTER, chemist recently engaged in the research department of The Barrett Co., Edgewater, N. J., from which he resigned on account of ill health, was drowned in Lake Nashotah, near Oconomowoc, Wis., on Oct. 13. He was undergoing treatment at a local sanitarium, to recover from a complete physical breakdown.

Colonel JARED RICE SMITH of Augusta, Ga., died on Oct. 10. Colonel Smith was born in Berryville, Clark County, Virginia, July 27, 1847. According to the *American Fertilizer*, at the age of 16 he joined the Confederate Army and served throughout the remainder of the war. At its conclusion he returned to Clark County, Virginia, and shortly after became clerk of court of Clark County, which office he held for a number of years. He was subsequently engaged in mining in Virginia; and later, while still a young man, became associated with the George W. Graflin Co., of Baltimore, in the fertilizer-manufacturing business. He went to Atlanta for it and in 1880 removed to Augusta to take charge of its Southern business, making his home in that city. He became president of the Georgia Chemical Works, which office he held up to the time of his death. A part of the intervening time he lived at Richmond, where he was general sales manager of the Virginia-Carolina Chemical Co. In 1913 he returned to Augusta, and had since resided there.

In 1903 Mr. Smith was married to Mrs. Anna Platt Heard, of Augusta, who survives him as well as one son, Charles L. Smith, of New Mexico, and two daughters by an earlier marriage, Mrs. Hamlin P. Briggs, of Raleigh, N. C., and Mrs. Edwin Calhoun, of Chester, S. C.

Mr. Smith was a great sufferer for the last 3 years of his life, having developed angina pectoris 3 years ago. At that time it appeared as though he could live only a short time, as his suffering was intense during the attacks. However, he was afforded a measure of relief by his physician, and a method of treatment was adopted which if instantly available could check the attacks. He made a magnificent fight for 3 years.

In the early hours of Oct. 10, Mr. Smith was seized with a sudden attack, and died in a few minutes. He was buried in Summerville cemetery, the Hill, Augusta, Ga., on the afternoon of Oct. 12. The civic bodies of Augusta, and the Rotary Club, of which he was a life member, attended the funeral in a body from the Church of the Good Shepherd, of which Mr. Smith was a member.

Mr. Smith was indeed the dean of the fertilizer industry, to which he had given practically his whole active life. He was an honorary member of the National Fertilizer Association.

Market Conditions

In Chemical, Metallurgical and Allied Industries

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities
Prevailing Prices and Market Letters From Principal Industrial Centers

Economics—Is It a Basis for Sound Executive Action or Is It Bunk?

The Established Value of Economic Principles to Business Trends Brings Up the Question, Are They Useful to the Individual Business?

IT IS NOT inappropriate at this moment to consider the subject of economics and its relation to business. The report of the convention of the Society of Industrial Engineers which appears on another page of this issue summarizes the opinions of prominent men on this timely subject. But such conventions must and do speak generalities. What we are really interested in is the *argumentum ad hominem.* How does economics affect my business? True, the index number is going up, but my costs and selling prices are not affected. True, someone told me that Babson predicts better business for a while at least, but mine has not changed or is worse than in April. Is this economics stuff sound or is it bunk? How can it benefit me in my decisions?

A Characteristic Reaction Against Economics

Let us get down to a few brass tacks if possible and endeavor to locate the connection between the general and the particular. First let us look at Babson. I was talking to a textile manufacturer during the winter of 1920. He was wealthy and successful. He was not war wealthy, but wealthy because of 40 years of successful effort. "Economics is all right in its place," he remarked, "but you can't run a business from Babson's charts. The movements are too general to make specific application possible."

Just about that time Babson began to shout "Beware!" "Look out for the inevitable deflation period!" Executives with orders booked 6 months ahead for full capacity laughed, if they paused even long enough to do that. A few st pped and thought and then they stopped buying raw materials and cut down inventories. "Idiots!" exclaimed the rest of the world if they knew. And then—well, the story is history now. The deflation came with a dull thud and business failures reached unprecedented heights. Babson and those who studied economics were right. They expected and were prepared for deflation. Economics "worked" in business problems. All logic aside and all pet theories eliminated, America's most rigid test has been applied—the pragmatic test. Does it work? Is it successful? If it is, it's right. And economics has established beyond a doubt its utility in business, your business, my business, any business.

Babson's Use of Statistics and Their Economic Interpretation

To return to Babson for a minute and the so-called Babson chart. Those of you who subscribe to his service know what the chart is: It is a weighted index, a composite of twelve subjects. Each subject has intrinsic value as a sign of business health or the lack of it. At present these twelve subjects which are composited include check transactions, new building, failures, money rates (domestic and foreign), foreign trade, commodity prices, stock prices, railroad earnings, crops, Canadian conditions, immigration. Each of these is carefully weighted, seasonal variations are allowed for and a composite curve is constructed which might be called the curve of business value. This curve is studied in relation to another curve called the country's net gain or growth. During boom periods the business curve is above the net growth curve and during periods of depression it is below it. The area between the two curves during a boom period will equal the area below during the subsequent period of depression on the assumption that action and reaction will inevitably be equal. We are at present over half way through the reaction period which followed the war boom, with conditions on the mend.

Arbitrary and Therefore Unreliable, Howls the Critic

It will probably at once occur to many that the weighting on such a chart is of necessity arbitrary, that the curve representing the country's net growth is also arbitrary and that when you subtract one arbitrary unit from another the result can have but little significance. The answer to that is that it works. You can argue yourself blue in the face. You can invoke the old saying (and many do): There are lies, damn lies and statistics. You can say complacently that you'd rather have a man with business sense than all the economic statistics in the world (and many say that too). But you can't blast away the fact that this chart, with whatever empirical limitations there are, has been a reliable indicator of business health.

We are not trying to sell Babson. In fact we are not sure that we are not already liable to a copyright law-suit for the discussion so far. But the point that we wish to make is that economic statistics which are studied in the light of economic laws reveal business conditions accurately and no one can afford to neglect them.

The Individual Enterprise and Not Business in General

A Complementary Study by the Executive Necessary

Neither Babson nor anyone else would attempt or pretend to run a business solely on a basis of such a chart of general business conditions. Small variations which would break even large corporations must inevitably be lost in the vast composite sweeps of the curve. What you as the head of a business unit should do in addition is to construct and study such curves for your own business. Here, for example, is one set of curves which would be of inestimable value (and very few people construct such a set or any curves for that matter). The production curve and the sales and stock reserve curve on each commodity manufactured! Variations in the differences between these two curves could form a reliable basis for production.

An example will illustrate. A company was producing a commodity which had a distinctly seasonal demand. Each year a stock was built up to an arbitrary figure and the plant shut down. Each year inevitably the demand ran away with the stock and

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14

This week	157.71
Last week	156.10
November, 1921	146.82
November, 1920	240
April, 1918 (high)	286
April, 1921 (low)	140

Relatively little change in the weighted index over last week's figure. Three commodities dropped slightly, citric acid, nitric acid and linseed oil. The price of acetic acid advanced slightly but not sufficiently to counterbalance the drop of the three others. For practical purposes this change is negligible and taken in connection with information from the various correspondents the market may be considered steady and strong.

orders piled up in spite of night and day production. Each year the stock was increased and each year it was regularly wiped out. The stock became more and more valuable as its size was increased. Each year the argument was more and more heated: increase the plant capacity or the size of the stock before the plant is shut down. The executive was torn between desire to get all the business possible and the hesitancy to tie up capital either in plant or stock. A typical executive problem with nothing but empirical data and the much touted "business sense" to solve it with. The result, confusion!

It is the old story of the psychological dilemma: "I want to eat it, for it looks like a mushroom. But I am afraid to eat it, for it might be a toadstool." For heaven's sake, find out the difference between mushrooms and toadstools and stop worrying. That is just what a study of statistics in the light of economic laws will do to many executive problems. It will show them the difference between mushrooms and toadstools.

We can think of a dozen statistical charts which every business executive will ultimately be using just as assiduously and eagerly as he is using engineering skill now. Why not give the matter thought? If charts work for general business conditions, so they will for individual business conditions. And the man with only "business sense" will ultimately take a place analogous to that which the "practical" engineer holds now—valuable still for his hunches and ideas, but having to be carefully checked by scientific business methods and sound economics.

Erratum

We believe that very few of our readers were misled by the obvious error on last week's market pages. In discussing the so-called invisible exchange from America to Europe an estimated value for 1921 of one and one-half million dollars was mentioned. This of course should have been one and one-half billion dollars. We tried to blame the composing room and the proofreader but they produced the manuscript in our own handwriting—it read "million."

Certainly one and one-half million dollars would not be much of a factor in allowing our trade balance to remain favorable and still permit the payment of interest and principal on foreign loans. We apologize and wish to call attention again to Secretary Hoover's ingenious analysis of the situation—an analysis which may have suffered in the eyes of some through our error.

The Trend of the Chemical Market

The tariff bill went into effect before Oct. 1, but October prices showed the first effect of the new law. Materials which are imported but on which the protection is greater than previously tended to advance. Even some which lost protection showed some advance. Consumers have in general shown much more marked interest and so-called conservative buying methods have to a large extent disappeared. Pronounced optimism is fairly widespread and many large producers are sold up on important commodities.

Exports do not stir observers and dealers to much enthusiasm. Even caustic soda and soda ash buyers have not been inclined to purchase for foreign countries. A hope that this is a passing phase is expressed and activity in the Far East, coming as it does concurrently with Secretary Hoover's ruling, strengthens this hope.

Among the products which rose in price early in the month—all imported products—were barium chloride, barium carbonate, prussiate of soda and caustic potash.

The rise in the price of methanol was the most important single feature. From 72c. per gal. at the beginning to 92c. as the closing price for the month is rather spectacular. Naturally other wood products and derivatives showed a similar but not proportional rise. Formaldehyde went from 10½c. per lb. to 13½c., an exceptional gain, as the price has scarcely varied in the last 6 months. Acetone, all grades of acetic acid and ethyl acetate were affected by the same rise. A new schedule was also given out by manufacturers of lead acetate.

White Arsenic Still Going Up

Commercial white arsenic is still scarce. Opening at 8½c. per lb., it is now selling at 10½c. The demand has been persistent and it is likely to stay so, for although the season is over, producers will undoubtedly attempt to build up exceedingly large stocks during the winter in order to be ready to supply a demand which is likely to be unprecedented next year for the arsenic insecticides.

Phenol, with a rise from 21c. per lb. to 31c. per lb., has also demanded much attention. Spot material is scarce and the rather limited stocks in the hands of dealers are being held for the higher prices which appear inevitable. Producers are in general sold up for some time to come. It is believed that the advance in price is largely due to speculative interests.

Very few reductions were recorded. Oxalic acid and chlorate of soda were forced down to meet foreign competition. Toward the end of the month yellow prussiate of soda, sal ammoniac, barium chloride and permanganate of potash dropped. These declines were largely due to lack of interest and a desire on the part of some dealers to close out stocks.

The market is on the whole strong and large producers are well satisfied with the volume. The next month should show continued strength and volume.

September a Good Month

Steel and Coal Production Indicates Continued Business Activity

The Department of Commerce reports that business activity was maintained during September. Iron and steel production has recovered from its low point in August. Unfilled orders pile up and prices for both iron and steel have increased sharply.

Pig Iron and Steel

The September pig-iron production totaled 2,034,000 tons, or 218,000 tons more than in August, but still below the recent peak of 2,405,000 tons reached in July. Steel-ingot production, prorated to 100 per cent, rose from 2,532,000 tons in August to 2,714,000 tons in September, but is below the maximum reached in May of 3,099,000 tons. Ingot production, so far this year, is nearly 70 per cent ahead of the same months of 1921. Merchant pig-iron production increased in September, but shipments, unfilled orders and stocks all declined.

Unfilled orders of the U. S. Steel Corporation continued to increase in September, reaching a total of 6,692,000 tons, or 742,000 tons more than at the end of August. Structural steel sales declined slightly in September. The movement of iron ore through the Sault Ste. Marie canal showed a decline of nearly 2,300,000 tons, compared with August. The prices of all iron and steel products rose sharply during September.

The production of zinc showed a further increase in September, while stocks continued to decline. Stocks of tin also showed a marked decline, compared with August. The prices of zinc and lead rose during September while tin declined slightly and copper showed no significant change.

Coal Production High

The resumption of bituminous mining at the beginning of September caused the output for the month to rise to 40,964,000 tons, compared to 22,328,000 tons in August. The September production is the largest since October a year ago except for March, when stocks were being built up in anticipation of the strike. Bituminous production has been maintained at a steady level of just under 10,000,000 tons a week ever since the settlement of the strike. The present rate of production is limited only by the ability of the railroads to handle the product.

Anthracite production increased from 161,000 tons in August to 4,979,000 tons in September. Mining in the anthracite field was not resumed until the second week in September; consequently the output for the month is considerably below the 7 to 8 million tons normally produced. Recent reports show that anthracite production is now averaging about 2,000,000 tons per week.

Coke production, both beehive and byproduct, increased in September. The price of coke declined somewhat. The same was true of the weighted mine average price of bituminous coal.

A Life-Preserver to Chinese-American Commerce

Secretary Hoover Issues Regulations for Carrying Out China Trade Act

It is safe to say that a large majority of Americans have been unacquainted with the handicap from which American traders in China have suffered. Great Britain, France and Japan long ago had freed corporations engaged in Chinese trade from the burden of their taxation, but American firms the stock of which was owned by Chinese or American residents of China were subject to American income tax regulation. Even some months ago, when a test case was put into the courts and a temporary injunction issued, little progress was made because firms hesitated to make themselves liable for accrued income taxes which might have been levied following an adverse court decision.

The China trade act became a law on Sept. 19 and it effectively removes the handicaps which have hitherto been felt. It provides that stock of corporations engaged in commerce in China, which is held by either Chinese or American residents of China, shall be exempt from federal income taxation. This will have the effect of attracting both Chinese and American capital into trade with America, which will be mutually advantageous.

Such trading is rather more difficult than ordinary exporting, for it means always a two-way trade. American goods can be distributed with a fair degree of ease, but the Chinese goods must be collected in small quantities over a wide area. Large production centers are a modern Occidental development.

A registration and a nominal fee of $100 are all that are required to incorporate a China trade company.

Such information as is necessary may be obtained from the Department of Commerce.

The act is looked on as a great step forward and it is distinctly to be hoped that some of the hundreds of companies which were forced out by the unfavorable conditions will be lured back into the work again.

The New York Market

NEW YORK, Oct. 30, 1922.

A few price changes were about the only features of the chemical market last week. New prices were announced on all grades of acetic acid on account of the upward revision on acetate of lime quotations. Heavy purchases of white arsenic have again caused dealers to advance prices. The prussiates tended to ease off during the past 2 weeks. Producers of chlorate of soda announced a reduction in selling prices. All barium products are being well sustained at recent quotations. Bichromate of soda is holding its firm tendency under a fair inquiry for moderate quantities. The domestic demand for caustic soda and soda ash continues exceedingly heavy and leading producers are quite satisfied with the volume of new business. The export inquiry was rather dormant during the interval. One of the strongest items on the list was phenol. Prices soared to 30c. per lb. early in the week for limited lots, with a very strong tendency toward much higher levels. Producers are sold ahead far into the future and there seems to be no relief for some time to come.

GENERAL AND SPECIAL CHEMICALS

Acetate of Soda—The spot market continues quite firm and sellers are offering limited lots at 8c. per lb. The scarcity of supplies is proving a sustaining feature to the market.

Acetic Acid—All producers announced a new advance on the various grades. Commercial, 28 per cent, packed in barrels, is quoted at $2.92½ per 100 lb. in carload lots. The 56 per cent is being held around $5.85 per 100 lb. in carload lots, and glacial 99 per cent at $11.16 per 100 pounds.

Arsenic Oxide—Spot quotations are slightly higher and it is doubtful if better than 10¾c. per lb. can be obtained. The range is from 10¾@11c. per lb. Recent heavy buying from the insecticides has reduced spot supplies.

Barium Carbonate—Imported material is offered on the basis of $75 per ton on spot. Several fair-sized sales were transacted at this level, with the range up to $80 per ton for smaller lots. Demand was moderate and in most cases for small quantities.

Bichromate of Soda—This market is in a firm position, with leading producers asking 7⅝@7¾c. per lb. Second hands report several sales at 7½@7¾c. per lb. for spot goods.

Chlorate of Soda—Domestic producers have reduced selling prices to 6¼@6½c. per lb., f.o.b. works, for November shipment. Imported goods on spot is being held at 6¾c. per pound.

Fluoride of Soda—Sales of imported material are reported on the basis of 9¾c. per lb., with the market quite firm at this level. Recent buying has greatly reduced spot supplies.

Nitrite of Soda—Several lots of imported goods were offered at 9c. per lb. on spot and at 8¾c. to arrive. Domestic factors are unchanged in their views at 10c. per lb., f.o.b. works.

Sulphide of Soda—Domestic producers are quoting the market for 60-62 per cent fused at 4¾@5c. per lb. The broken variety is held at 5@5½c. per lb. Importers are offering fused material at 4c. per lb., carload lot basis on spot. Demand is only routine.

Zinc Chloride—Domestic factors quote the fused at 7c. per lb. in quantity lots. Ground material is quoted at 8c. per lb. Importers are offering goods at greatly reduced figures.

Phenol—This item was undoubtedly the strongest commodity on the list. Spot goods was extremely scarce and leading factors reported a well sold up condition. Several odd lots changed hands during the interval at prices ranging from 28c. per lb. early in the week to 31c. per lb. during the latter part. The general tone is quite firm.

VEGETABLE OILS

Linseed Oil—The spot and nearby shipment market is not very active, but futures were in fair demand during the interval. Spot oil held around 88@89c. per gal. in carload lots, with November shipments quoted at 86c.

Castor Oil—Although dealers in this product reported a very firm tone, producers announced a reduction of ½c. per lb. on all grades. The decline was primarily due to keen competition. The No. 3 grade was quoted at 12c. per lb., with the AA at 12½c. per lb. in barrels.

Olive Oil—There has been a pronounced scarcity in prime foots oil and prices on spot are up to 9¾c. per lb. Nearby shipments are being quoted at 9½c. per lb. Denatured oil closed unchanged at $1.15@$1.20 per gal. Edible oil was available at $1.70@$2.30 per gallon.

Peanut Oil—Prices for this material are merely nominal, due to the lateness of the new crop. Prices range from 8¾@9¼c. per lb., tank cars, f.o.b. mills. Refined oil on spot was in limited supply, with quotations heard around 12½@13c. per pound.

The Iron and Steel Market

PITTSBURGH, Oct. 27, 1922.

Steel ingot production is at 36,000,000 or 37,000,000 tons a year, or say 70 per cent of capacity. There has been no important change in the rate since the middle of September, merely a slight further increase after the sharp recovery from the August decrease. All present prospects are that the next change in the rate of production will be a decrease, through some mills not having sufficient orders to maintain their present production rate.

Shipping conditions have improved somewhat. All the current output of steel is being shipped, together with a little of the steel that accumulated recently on account of car shortages. Some embargoes remain, but on the whole there is not much inconvenience in this respect.

The current turnover in the finished steel markets is the lightest for any time this year. The market has been quiet for several weeks and may now be described as stagnant in the majority of lines.

BETTER DELIVERIES OF STEEL

There is no plain evidence that the rate of steel consumption, on the whole, has decreased. There is an easier situation because mills are making better deliveries. Many buyers are still seeking heavier deliveries. They now act upon this desire by urging mills to make heavier deliveries on old contracts, taken at prices below those now ruling, whereas a few weeks ago many buyers were going into the open market and making fresh purchases for early deliveries, paying the delivery premiums then ruling.

There were delivery premiums on bars, shapes, plates and sheets. These premiums have been decreasing for several weeks and they are now relatively unimportant, usually applying only on small lots or on extremely early shipment. In sheets there is the remarkable report that some independent mills are willing to sell, on attractive business, at the Steel Corporation prices, based on 3.55c. for common black, and this is not due to competition by the corporation, since the corporation has been sold out for more than a month, having no further offerings to make until it opens order books for the first quarter of the new year.

Basis Prices Unchanged

Basis prices for steel products, prices that do not contain a delivery premium, are unchanged. In all the products the latest change was an advance, but the only recent advance was that of Oct. 19, in pipe. Bars, shapes and plates are 2c., nails $2.70, tin plate $4.75 and merchant steel pipe 66 per cent basing discount.

The condition in the steel market is a familiar one, new buying having practically ceased, except in cases of new wants arising, in construction jobs, freight cars, etc., while the mills are engaged in filling old orders, taken at various prices during the rise. With the sales policy followed by all the large mills before the war order books would now be of about the same size throughout the industry, relative to capacity. Before the war mills normally sold at the same prices and there was never much difference between prices of the Steel Corporation and the independents. All the authorities in the trade would then have agreed that much difference was obviously impossible. Since the armistice, prices, as between the Steel Corporation and the independents, have been different more often than not. In the past 7 months, since the market passed its low point, there have been various prices, the result being that order books now are of various sizes. The trade, therefore, will not run for as long a time in a quiet period with prices unchanged. Some producers will be disposed to seek additional business by cutting prices while other producers are still well supplied with orders. The price cutting may not lower the general market level or force the mills provided with large order books to modify contract prices at once.

Large consumers of steel are exhibiting a desire to know what steel is going to cost them for 1923 delivery, but are indisposed to attempt to ascertain by starting negotiations. As mills have business on books to protect, they would not name as low prices now as they might be glad to quote a few months hence.

Coke and Pig Iron

Connellsville coke, which had a sharp slump from $12 to $8, as noted in last week's report, has since then merely become a trifle easier. Small lots pressing on the market go at $7.50, while fair-sized lots, for delivery over a week or two, are likely to command $8 and contracts to the end of the year would not be taken at less than $8.50 or $9. Operators are suggesting, as to contract prices, that December is likely to bring fresh car shortages and higher spot prices, whereby contract prices should be higher than the present spot market, to strike the average. It is not shown, however, that the spot market will not decline much more in the next few weeks.

Pig iron continues stagnant, there being scarcely any inquiry. While it is well recognized that the trend in prices is downward and that the market will scarcely halt until it finds a level much below the present, the absence of important inquiry prevents there being much pressure on prices. Bessemer has continued to sell in odd lots at $33 valley. A fair tonnage of basic has sold at last week's quotation of $30 valley. Transactions in small lots of foundry have developed a price of $30 valley, $2 below the quotation of a week ago.

General Chemicals

Current Wholesale Prices in New York Market

		Carlots F.o.b. N. Y.	Less Carlots F.o.b. N. Y.
Acetic anhydride	lb.	–	$0.38 – $0.40
Acetone	lb.	$0.19 – $0.20	.20½ – .22
Acid, acetic, 28 per cent	100 lb.	2.92½ – 3.00	3.05 – 3.20
Acetic, 56 per cent	100 lb.	5.85 – 5.90	5.95 – 6.25
Acetic, glacial, 99½ per cent, carboys	100 lb.	11.16 – 11.20	11.25 – 11.50
Boric, crystals	lb.	.11 – .11½	.11¾ – .12
Boric, powder	lb.	.11 – .11½	.11¾ – .12½
Citric	lb.	–	.51 – .52
Hydrochloric	100 lb.	1.10 – 1.20	1.25 – 1.70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11¾ – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04½ – .04¾	.05 – .05½
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3.75
Muriatic, 20 deg. (see hydrochloric)		–	–
Nitric, 40 deg	lb.	.05½ – .05¾	.06 – .06½
Nitric, 42 deg	lb.	.06 – .06¼	.06½ – .07
Oxalic, crystals	lb.	.14½ – .14¾	.14¾ – .15½
Phosphoric, 50 per cent solution	lb.	.07½ – .08	.08½ – .09
Picric	lb.	.20 – .22	.23 – .27
Pyrogallic, resublimed	lb.	–	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	9.50 – 10.00	–
Sulphuric, 60 deg., drums	ton	12.00 – 14.00	–
Sulphuric, 66 deg., tank cars	ton	15.00 – 16.00	–
Sulphuric, 66 deg., drums	ton	19.00 – 20.00	20.50 – 21.00
Sulphuric, 66 deg., carboys	ton	–	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.00 – 20.00	–
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	–	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	–	.31 – .31½
Tartaric acid, imported, powdered	lb.	–	.31½ – .32
Tartaric acid, domestic	lb.	–	– .32
Tungstic, per lb. of WO	lb.	–	1.00 – .110c
Alcohol, ethyl (Cologne spirit)	gal.	–	4.75 – 4.95
Alcohol, methyl (see methanol)		–	–
Alcohol, denatured, 188 proof No. 1	gal.	–	.36 – .38
Alcohol, denatured, 188 proof No. 5	gal.	–	.36 – .38
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04½
Alum, potash, lump	lb.	.03½ – .03¾	.04 – .04½
Alum, chrome lump	lb.	.05 – .05¼	.05½ – .06
Aluminum sulphate, commercial	100 lb.	1.50 – 1.65	1.70 – 2.25
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.06¾ – .07¼	.07½ – .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.30½ – .31
Ammonium carbonate, powder	lb.	.08½ – .08¾	.09 – .09½
Ammonium nitrate	lb.	.06 – .06½	.06¾ – .07½
Amylacetate tech	gal.	–	2.35 – 2.50
Arsenic, white, powdered	lb.	.10 – .11	.11¼ – .11½
Arsenic, red, powdered	lb.	.12½ – .12¾	.13 – .13½
Barium carbonate	ton	75.00 – 77.00	78.00 – 80.00
Barium chloride	ton	100.00 – 102.00	103.00 – 105.00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate		.09 – .09½	.09¾ – .10
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½ – .04¾
Blanc fixe, dry	lb.	.04 – .04½	–
Blanc fixe, pulp	ton	45.00 – 55.90	–
Bleaching powder	100 lb.	2.00 – 2.10	2.15 – 3.25
Blue vitriol (see copper sulphate)		–	–
Borax	lb.	.05½ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.27 – .38	.28½ – .35
Calcium acetate	100 lb.	3.00 – 3.15	3.20 – 3.50
Calcium carbide	lb.	.04½ – .04¾	.05 – .05¼
Calcium chloride, fused, lump	ton	22.00 – 23.00	23.50 – 27.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02¼
Calcium peroxide	lb.	–	1.40 – 1.50
Calcium phosphate, tribasic	lb.	–	.15 – .16
Camphor	lb.	–	.86 – .87
Carbon bisulphide	lb.	.07 – .07¼	.07½ – .07¾
Carbon tetrachloride, drums	lb.	.10 – .10¾	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	–	.60 – .75
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chalk, precip.—domestic, light	lb.	.04¼ – .04½	–
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	–
Chalk, precip.—imported, light	lb.	.04½ – .05	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.05¾ – .06
Chloroform	lb.		.25 – .32
Cobalt oxide	lb.	–	2.00 – 2.10
Copperas	ton	21.00 – 22.00	23.00 – 30.00
Copper carbonate, green precipitate	lb.	.21 – .21½	.22 – .22½
Copper cyanide	lb.	–	.58 – .600
Copper sulphate, crystals	100 lb.	5.75 – 6.00	6.10 – 6.50¼
Cream of tartar	lb.	–	.26 – .27
Epsom salt (see magnesium sulphate)		–	–
Ethyl acetate com. 85%	gal.	–	.72 – .75
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	–	.90 – .95
Formaldehyde, 40 per cent	lb.	.13½ – .13¾	.14 – .14¼
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	–
Fullers earth—imported powdered	net ton	30.00 – 32.00	–
Fuse oil, ref.	gal.	–	2.75 – 2.90
Fusel oil, crude	gal.	–	1.65 – 1.85
Glauber's salt (see sodium sulphate)		–	–
Glycerine, c.p. drums extra	lb.	–	.18½ – .18¾
Iodine, resublimed	lb.	–	4.40 – 4.50
Iron oxide, red	lb.	–	.12 – .18
Lead acetate, white crystals	lb.	–	.11½ – .12½
Lead arsenate, powd.	lb.	.13 – .13½	.13½ – .14¼
Lead nitrate	lb.	–	.15 – .20
Litharge	lb.	.07¾ – .08	.08¾ – .09
Magnesium carbonate, technical	lb	.06 – .06½	.06¾ – .07¾
Magnesium sulphate, U.S.P.	100 lb	2.00 – 2.25	2.30 – 2.50
Magnesium sulphate, technical	100 lb.	–	1.00 – 1.80
Methanol, 95%	gal.	–	.90 – .92
Methanol, 97%	gal.	–	.92 – .94
Nickel salt, double	lb.	–	.11 – .11½

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Nickel salt, single	lb.	..... –	.12 – .12½
Phogene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	..... –	.40 – .45
Phosphorus, yellow	lb.	..... –	.30 – .35½
Potassium bichromate	lb.	.10 – .10½	.10½– .11
Potassium bromide, granular	lb.	..... –	.17 – .23
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80-85%	lb.	.06 – .06½	.06½– .06¾
Potassium chlorate powdered and crystals	lb.	.07½– .08	.08½– .09
Potassium cyanide	lb.	..... –	.55 – .57
Potassium hydroxide (caustic potash) 100	lb.	6.25 – 6.50	6.60 – 7.00
Potassium iodide	lb.	..... –	3.45 – 3.55
Potassium nitrate	lb.	.06½– .06¾	.07 – .08
Potassium permanganate	lb.	.16 – .16½	.16¾– .17
Potassium prussiate, red	lb.	....	.95 – 1.00
Potassium prussiate, yellow	lb.	.37½– .38	.38½– .38½
Rochelle salts (see sodium potas. tartrate)	....	....	..... – .....
Salammoniac, white, granular	lb.	.06½– .06¾	.07 – .07½
Salammoniac, gray, granular	lb.	.08¼– .08½	.08¾– .09
Salsoda 100	lb.	1.20 – 1.40	1.45 – 1.60
Salt cake (bulk)	ton	25.00 –27.00	......– ....
Soda ash, light, 58 per cent flat, bags, contract 100	lb.	1.60 – 1.67	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale 100	lb.	1.75 – 1.80	1.85 – 2.35
Soda ash, dense, in bags, resale 100	lb.	1.85 – 1.90	1.95 – 2.40
Sodium acetate	lb.	.08 – .08½	.08½– .09
Sodium bicarbonate 100	lb.	1.75 – 1.85	1.90 – 2.30
Sodium bichromate	lb.	.07½– .07¾	.08 – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼– .04½	.04¾– .05½
Sodium chlorate	lb.	.06½– .06¾	.07 – .07½
Sodium chloride	long ton	12.00 –13.00	......–......
Sodium cyanide	lb.	.19½– .21	.21½– .25
Sodium fluoride	lb.	.09¾– .10	.10¼– .10½
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract 100	lb.	3.35 – 3.40	3.75 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale 100	lb.	3.45 – 3.50	3.55 – 4.00
Sodium hydroxide (caustic soda), ground and flake, contracts 100	lb.	3.80 – 3.90	4.25 – 4.40
Sodium hydroxide (caustic soda) ground and flake, resale 100	lb.	4.00 – 4.15	4.40 – 4.60
Sodium hyposulphite	lb.	.02½– .02¾	.03 – .03½
Sodium nitrite	lb.	.09 – .09½	.09½– .10
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03¾– .04	.04¼– .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.22¾– .23	.23¼– .23½
Sodium silicate, (40 deg. in drums) 100	lb.	.80 – 1.00	1.05 – 1.25
Sodium silicate, (60 deg. in drums) 100	lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glaubers salt) 100	lbs.	.85 – .95	1.00 – 1.40
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04 – .04½	.04½– .05
Sodium sulphite, crystals	lb.	.03½– .03¾	.03¾– .04½
Strontium nitrate, powdered	lb.	.09½– .10	.10½– .12
Sulphur chloride, yellow	lb.	.04½– .05	.05½– .06
Sulphur, crude	ton	18.00 –20.00	......– .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour 100	lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone) 100	lb.	2.00 – 2.15	2.20 – 2.70
Talc—imported	ton	30.00 –40.00	......–......
Talc—domestic powdered	ton	18.00 –25.00	......–......
Tin bichloride	lb.	.10 – .10½	.10½– .10¾
Tin oxide	lb.	..... –	.39 – .40
Zinc carbonate	lb.	.14 – .14½	.14¾– .15½
Zinc chloride, gran.	lb.	.07 – .07½	.07¾– .08
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½– .08	.08½– .08¾
Zinc sulphate 100	lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude	lb.	$0.95 — $1.00
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.29 — .31
Aniline oil, drums extra	lb.	.16 — .17
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.35
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 — .32
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb.	.80 — .85
Benzoic acid, U.S.P.	lb.	.72 — .75
Benzoate of soda, U.S.P.	lb.	.57 — .65
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.53 — .55
Beta-naphthol, tech	lb.	.23 — .25
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Carbazol	lb.	.75 — .90
Cresol, U. S. P., in drums (100 lb.)	lb.	.14 — .20
Ortho-cresol, in drums (100 lb.)	lb.	.18 — .22
Cresylic acid, 97-99%, straw color, in drums	gal.	.60 — .65
Cresylic acid, 95-97%, dark, in drums	gal.	.55 — .58
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.50 — .60
Dimethylaniline	lb.	.32 — .34
Dinitrobenzene	lb.	.20 — 22
Dinitroclorbenzene	lb.	.21 — .22
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.32 — .34
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.85 — .90
Diphenylamine	lb.	.54 — .56
H-acid	lb.	.72 — .75
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.08 — .10
Monoethylaniline	lb.	.95 — 1.10
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½— .07
Naphthalene, balls	lb.	.07½— .08
Naphthionate of soda	lb.	.58 — .65
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	$0.15 — $0.10
N-W acid	lb.	1.20 — 1.30
Ortho-amidophenol	lb.	2.10 — 2.15
Ortho-dichlor-benzene	lb.	.17 — .20
Ortho-nitro-phenol	lb.	.80 — .85
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.12 — .14
Para-amidophenol, base	lb.	1.20 — 1.25
Para-amidophenol, HCl	lb.	1.25 — 1.30
Para-dichlorbenzene	lb.	.17 — .20
Paranitroaniline	lb.	.72 — .80
Para-nitrotoluene	lb.	.55 — .65
Para-phenylenediamine	lb.	1.55 — 1.60
Para-toluidine	lb.	.85 — .90
Phthalic anhydride	lb.	.35 — .38
Phenol, U. S. P., drums	lb.	.30 — .32
Pyridine	gal.	1.60 — 1.75
Resorcinol, technical	lb.	1.50 — 1.55
Resorcinol, pure	lb.	2.00 — 2.10
R-salt	lb.	.55 — .60
Salicylic acid, tech., in bbls.	lb.	.29 — .30
Salicylic acid, U. S. P.	lb.	.32 — .34
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.27 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.12 — .14
Sulphanilic acid, crude	lb.	.24 — .26
Tolidine	lb.	1.20 — 1.30
Toluidine, mixed	lb.	.30 — .35
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.30 — .35
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities f.o.b. N.Y.

Bayberry Wax	lb.	$0.19½— $0.20
Beeswax, refined, dark	lb.	.30 — .32
Beeswax, refined, light	lb.	.34 — .35
Beeswax, pure white	lb.	.36 — .40
Candellila, wax	lb.	.34 — .36
Carnauba, No. 1	lb.	.40 — .42
Carnauba No. 2, North Country	lb.	.25 — .26½
Carnauba, No. 3, North Country	lb.	.19 — .19½
Japan	lb.	.15 — .15
Montan, crude	lb.	.03¾— .04¼
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04 — .04¼
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½— .02¾
Paraffine waxes, refined, 118-120 m.p.	lb.	.03¼— .03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½— .03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 — .04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½— .04¾
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 — .05¼
Stearic acid, single pressed	lb.	.09 — .09½
Stearic acid, double pressed	lb.	.09½— .09¾
Stearic acid, triple pressed	lb.	.10½— .10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$7.00 — ....
Rosin E-I	280 lb.	7.05 — ....
Rosin K-N	280 lb.	7.10 — $7.15
Rosin W. G.-W. W	280 lb.	7.75 — 8.25
Wood rosin, bbl.	280 lb.	6.25 — .....
Spirits of turpentine	gal.	1.65 — 1.70
Wood turpentine, steam dist	gal.	1.35 — .....
Wood turpentine, dest. dist	gal.	1.25 — .....
Pine tar pitch, bbl.	200 lb.	...... — 6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	...... — 12.50
Retort tar, bbl.	500 lb.	...... — 11.00
Rosin oil, first run	gal.	.38 — .....
Rosin oil, second run	gal.	.41 — .....
Rosin oil, third run	gal.	.48 — .....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	.90
Pine oil, pure, dest. dist	gal.	.85
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.	.25
Pinewood creosote, ref.	gal.	.52

Fertilizers

Ammonium sulphate, f.a.s., N. Y., double bags	100 lb.	3.65 — 3.75
Blood, dried, f.o.b., N. Y.	unit	4.60 — .....
Bone, 3 and 50, ground, raw	ton	42.00 — 44.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 — 3.20
Nitrate of soda	100 lb.	2.35 — 2.45
Tankage, high grade, f.o.b. Chicago	unit	4.50 — 4.60
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50 — 4.00
Tennessee, 78-80%	ton	7.00 — 8.00
Potassium muriate, 80%	ton	33.00 — 34.00
Potassium sulphate	unit	1.00 — .....

Crude Rubber

Para—Upriver fine	lb.	$0.24 — .24½
Upriver coarse	lb.	.18½— .18¾
Upriver caucho ball	lb.	.18 — .18¼
Plantation—First latex crepe	lb.	22½— .22
Ribbed smoked sheets	lb.	22¼— .22
Brown crepe, thin, clean	lb.	.20 — .20
Amber crepe No. 1	lb.	.20 — .20

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.12	— $0.12½
Castor oil, AA, in bbls	lb.	.12½	— .13
China wood oil, in bbls	lb.	.12¼	— .12½
Coconut oil, Ceylon grade, in bbls	lb.	.08¼	— .08½
Coconut oil, Cochin grade, in bbls	lb.	.08¾	— .09
Corn oil, crude, in bbls	lb.	.08¼	— .09
Cottonseed oil, crude (f. o. b. mill)	lb.	.07¾	— .....
Cottonseed oil, summer yellow	lb.	.10¼	— .10½
Cottonseed oil, winter yellow	lb.	.11¼	— .11½
Linseed oil, raw, car lots (domestic)	gal.	.90	— .91
Linseed oil, raw, tank cars (domestic)	gal.	.87	— .88
Linseed oil, boiled, in 5-bbl lots (domestic)	gal.	.92	— .94
Olive oil, denatured	gal.	1.15	— 1.17
Palm, Lagos	lb.	.07	— .07½
Palm, Niger	lb.	.06¼	— .06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08¾	— .09
Peanut oil, refined, in bbls	lb.	.12½	— .13
Rapeseed oil, refined in bbls	gal.	.77	— .78
Rapeseed oil, blown, in bbls	gal.	.85	— .86
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11¼	— ....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.08¾	— .09

FISH

Light pressed menhaden	gal.	$0.51	— ....
White bleached menhaden	gal.	.54	— .55
Blown menhaden	gal.	.61	— ....
Whale Oil, No. 1. crude, tanks, coast	gal.	.45	— .48

Miscellaneous Materials

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$600.00	$800.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	65.00	— 80.00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	15.00	— 17.00
Barytes, ground, white, f.o.b. mills	net ton	17.00	— 23.00
Barytes, ground, off color f.o.b. mills	net ton	13.00	— 21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	— 24 00
Barytes, crude f.o.b. mines	net ton	8.00	— 9.00
Casein	lb.	.10½	— .13
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00	— 8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00	— 9.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00	— 20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	— 12.00
China clay (kaoli n)ground, f.o.b. Virginia points	net ton	13.00	— 20.00
China clay (kaolin), imported, lump	net ton	16.00	— 20.00
China clay (kaolin), imported, powdered	net ton	30.00	— 35.00
Feldspar, No. 1 pottery grade	long ton	7.00	— 7.50
Feldspar, No. 2 pottery grade	long ton	5.75	— 5.90
Feldspar, No. 1 soap grade	long ton	7.00	— 7.50
Feldspar, No. 1 Canadian, for mill	long ton	21.00	— 22.00
Graphite, Ceylon lump, first quality, f.o.b. N. Y	lb.	.05	— .05½
Graphite, Ceylon chip	lb.	.04	— .04½
Graphite, high grade amorphous crude	ton	35.00	— 50.00
Kieselguhr, f.o.b. mines, Cal	per ton	40.00	— .....
Kieselguhr, f.o.b. N. Y	per ton	50.00	— 55.00
Magnesite, crude, f.o.b. California mines	per ton	12.00	— 15.00
Pumice stone, imported	lb.	.03	— .05½
Pumice stone, domestic, lump	lb.	.05	— .05
Pumice stone, domestic, ground	lb.	.06	— .07
Shellac, orange fine	lb.	.66	— .68
Shellac, orange superfine	lb.	.68	— .70
Shellac, A. C. garnet	lb.	.70	— .72
Shellac, T. N	lb.	.65	— .66
Silica, glass sand, f.o.b. Indiana	per ton	1.50	— 2.50
Silica, sand blast material, f.o.b. Indiana	per ton	2.50	— 5.00
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	16 00	— 16.00
Silica, building sand, f.o.b. Pa	per ton	2.00	— 2.75
Soapstone	ton	12.00	— 15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00	— 12.00
Talc, 200 mesh, f.o.b. Georgia	ton	7 50	— 12.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	15.00	— 17.00

Refractories

Bauxite brick, 56% Al_2O_3, f.o.b. Pittsburgh	per 1,000	$130.00
Chrome brick, f.o.b. Eastern shipping points	net ton	50
Chrome cement, 40-50% Cr_2O_3	net ton	23–27
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b.. Eastern shipping points	net ton	23.00
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	35–40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	26–28
Magnesite brick, 9-in. straight (f.o b. works)	net ton	60
Magnesite brick, 9-in. arches, wedges and keys	net ton	70
Magnesite brick, soaps and splits	net ton	90
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	48–50
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	50–53
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	45–47
Silicon carbide refractory brick, 9-in	1,000	1100.00

Ferro-Alloys

Ferrotitanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00	— $225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.10	— 10½
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.10½	— .11
Ferromanganese, 78-82% Mn, Atlantic seaboard	gross ton	67.50	— 69.00
Spiegeleisen, 19-21% Mn	gross ton	37.00	— 38 00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00	— 2 25
Ferrosilicon, 10-15%	gross ton	38.00	— 40.00
Ferrosilicon, 50%	gross ton	63 00	— 65.00
Ferrosilicon 75%	gross ton	115.00	— 120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.75	— .80
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00	— ......
Ferrovanadium, 30-40% per lb. of contained V.	lb.	3.50	— 4.00

Ores and Semi-finished Products

All f.o.b. New York Unless Otherwise Stated

Bauxite, domestic, crushed and dried, f.o.b. shipping points	net ton	$6.00	— $9.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	22.00	— 23.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	19 00	— 20.00
Coke, foundry, f.o.b. ovens	net ton	10.50	— 11 00
Coke, furnace, f.o.b. ovens	net ton	8.00	— 8.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	15 00	— .....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	17.50	— 19.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½	— .01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.45	— ......
Manganese ore, chemical (MnO_2)	net ton	70.00	— 75.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	.80	— .85
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27.00	— ......
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.10½	— .11
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.12	— .13½
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	Nominal	
Rutile, 95% TiO_2 per lb. ore	lb.	.12	— .....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	8.00	— 8.25
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	7.75	— 8.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25	— 1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25	— 2.50
Vanadium pentoxide, 99%	lb.	12.00	— 14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00	— .....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½	— .13½

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

	Cents per Lb.
Copper, electrolytic	13.75–13.875
Aluminum, 98 to 99 per cent	20.00–21.00
Antimony, wholesale lots, Chinese and Japanese	6.75–7.00
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	32.00–33 00
Nickel, ingot and shot, resale	30.00–31.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	35.875
Lead, New York, spot	6.50–6.60
Lead, E. St. Louis, spot	6.40
Zinc, spot, New York	7.30–7.35
Zinc, spot, E. St. Louis	7.00–7.05

OTHER METALS

Silver (commercial)	oz.	$0.67½
Cadmium	lb.	1.15
Bismuth (500 lb. lots)	lb.	2.35@2.40
Cobalt	lb.	3.00@3.25
Magnesium, ingots, 99 per cent	lb.	1.00@1.05
Platinum	oz.	$108.00
Iridium	oz.	275.00@300.00
Palladium	oz.	55.00
Mercury	75 lb.	73.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.00
Copper bottoms	30.00
Copper rods	19.75
High brass wire	18.75
High brass rods	16.75
Low brass wire	19.60
Low brass rods	20.25
Brazed brass tubing	23.00
Brazed bronze tubing	28.00
Seamless copper tubing	24.75
Seamless high brass tubing	22.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

Copper, heavy and crucible	11.00@11.25
Copper, heavy and wire	10.50@10.75
Copper, light and bottoms	8.50@ 8.75
Lead, heavy	4.50@ 4.75
Lead, tea	3.25@ 3.50
Brass, heavy	5.50@ 5.75
Brass, light	5.00@ 5.25
No. 1 yellow brass turnings	5.50@ 5.75
Zinc	2.25@ 2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in and heavier, from jobbers' warehouses in the cities named:

	New York	Chicago
Structural shapes	$2.90	$2.90
Soft steel bars	2.80	2.80
Soft steel bar shapes	2.80	2.80
Soft steel bands	3.40	3.40
Plates, ¼ to 1 in. thick	2.90	2.90

Industrial

Financial. Construction and Manufacturers' News

Construction and Operation

Alabama

MONTGOMERY — The Woco Pep Co., recently organized with H. H. Gardner, Montgomery, as president, has plans under way for the construction of an oil storage and distributing plant on local site, with initial capacity of about 65,000 gal.

MOBILE—The Mobile Paint Mfg. Co. is planning for extensions in its plant for considerable increase in capacity. Additional machinery will be installed. W. A. Benson is president.

DECATUR—The Alabama Water Co., Albany, Ala., is planning for the installation of a new filtration plant at Decatur.

California

LOS ANGELES—The Pan-American Petroleum & Transport Co., 120 Broadway, New York, with branch at Los Angeles, has tentative plans under consideration for the construction of a new oil-refining plant at Los Angeles Harbor. Application has been made to the Harbor Commission for permission. The company is affiliated with the Mexican Petroleum Co.

LOS ANGELES—Fire, Oct. 9, destroyed a portion of the oil refinery of the Richfield Oil Co., Santa Fe and 24th Aves., including distributing plant, with loss estimated at about $250,000, including buildings and equipment. It is planned to rebuild.

LOS ANGELES—The Atlas Brass Foundry Co. has awarded a contract to V. P. Gilbert, 413 Citizens National Bank Bldg., for the erection of a new 1-story foundry, 36x73 ft., at 1901-3 Santa Fe Ave.

OAKLAND—The West End Chemical Co., producer of borax products, has work under way on extensions to its refining plant at Chauncey, N. Y. Construction of new refineries has also been commenced at Chicago, Ill., and Monongahela, Pa. F. M. (Borax) Smith, San Francisco, heads the organization.

LOS ANGELES — The Ventura Associated Oil Co. has preliminary plans in progress for the construction of a new storage and distributing plant at Los Angeles Harbor.

Florida

TAMPA—The Tampa Gas Co. is planning for extensions and improvements in its artificial gas plant, to include the installation of additional equipment. Roscoe Nettles is general manager.

PALATKA—R. W. Lyle, Palatka, has plans under way for the establishment of a brick-manufacturing plant on local site. The initial equipment will give employment to about 80 men.

BRADENTOWN—The Texas Oil Co. has plans in progress for the construction of a new oil storage and distributing plant on local site. A pumping plant will be installed.

Illinois

CHICAGO—Thayer & Co., manufacturers of soap products, have leased the 3-story building at Armitage and Mango Aves., comprising about 30,000 sq.ft. of floor space, for a new plant. Immediate possession will be taken.

ROCKFORD—The Rockford Malleable Iron Works, Inc., has construction under way on a 1-story plant addition, 90x120 ft., on People's Ave., fronting on the Chicago, Burlington & Quincy Railroad, to be equipped for annealing work. It will cost about $45,000. George C. Forbes is secretary and treasurer.

Indiana

VINCENNES — The Blackford Window Glass Co., recently reorganized with a capital of $1,000,000, has plans in progress for the erection of a new local plant for plate glass production. A tract of 6 acres of land has been secured as a site. The works will include a specialty division for the grinding, polishing and beveling of the output, as well as a clay plant for raw material service. Frank Bastin is president, and Ira D. Schaffer, treasurer.

LAFAYETTE—Fire, Oct. 14, destroyed the oil-distributing and storage plant of the National Refining Co., with loss estimated at about $100,000. It is planned to rebuild. Headquarters of the company are at 1404 East 9th St., Cleveland, Ohio.

Kansas

COFFEYVILLE—The Sinclair Consolidated Oil Co., 45 Nassau St., is making a number of changes and improvements at its local oil refinery, heretofore devoted largely to lubricating oil production, and plans to have the plant complete and in full operation by the close of the year. It will have a capacity of about 5,000 bbl. per day. The company is increasing production at its Kansas City refining plant, which has been handling about 5,000 bbl. daily, and a variety of refined oils are being produced. It is reported that the company is planning for the construction of a second unit at its refinery at Houston, Tex.

Louisiana

HOUMA — The Southern Synthetic Co., recently organized, has plans in progress for the erection of a new local plant for the manuafcture of synthetic marble from oyster and sea shells. It is estimated to cost in excess of $45,000. Robert J. Younger and R. E. Griffing, Jr., head the company.

LAFAYETTE—The Lafayette Sugar Refining Co., New Orleans, is reported to be planning for the rebuilding of its refining plant at Lafayette, partly destroyed by fire, Oct. 12, with loss estimated at about $275,000, including machinery.

SHREVEPORT—The Caddo Cotton Oil Co. has tentative plans under consideration for the rebuilding of its local mill, destroyed by fire, Oct. 11, with loss approximately $100,000, including machinery.

NEW ORLEANS—Fire, Oct. 10, destroyed a portion of the plant of the Atlantic Paint Co., Perdido St., with loss estimated at close to $35,000, including equipment.

Maryland

BALTIMORE—The Baltimore Steel Co., Eastern Ave. and Eden St., will soon commence the erection of two 1-story plant additions, estimated to cost close to $45,000. Other buildings are planned to cost approximately $50,000. Gilbert A. Wehr is president.

BALTIMORE—The Federal Yeast Corp., Colgate Station, recently organized, has acquired the local property of the Colgate Products Co., located on Colgate Creek, for a consideration said to be $182,000. It will be used as a new plant for the manufacture of yeast products. The company is headed by Francis W. Little and Sidney A. Goodman.

BALTIMORE—Loyola College, 700 North Calvert St., has commenced foundations for a new chemistry and biology building at the institution, to be 2-story and estimated to cost close to $200,000, including equipment. Otto G. Simonson, Casualty Bldg., is architect.

Michigan

RIVER ROUGE—The Detroit Sand Lime Brick Co., 1008 Vinton Bldg., Detroit, will soon commence the erection of its proposed new plant, on site acquired a number of months ago, estimated to cost close to $100,000, including equipment.

Missouri

KANSAS CITY—The Great Eastern Mills Co., 440 7th Ave., Pittsburgh, Pa., has leased a local building at 1222 West 9th St. for the establishment of a new branch mill for the manufacture of sugar. Machinery will be installed at once.

CARROLLTON—The Sinclair Consolidated Oil Co. is planning for improvements in its local plant. New power equipment and other machinery will be installed.

JOPLIN—The Osborn Paper Co. is planning for the erection of a new 2-story building, to cost about $37,000. Plans will be drawn at an early date.

Mississippi

MOSS POINT—The Southern Paper Co. has plans in progress for extensions in its plant, to include a new paper and pulp mill, to increase the output to about 100 tons a day. A new power house will be built. E. H. Mayo is general manager.

Montana

NEIHART—The new local concentrating mill of the American Zinc & Lead Co., for which a building contract recently was awarded, will have an initial capacity of about 450 tons daily. It will handle silver, lead and copper from the company's properties in the Silver Dike district in this section. The company is making extensions in its zinc oxide operations, and plans for enlargements in its plant devoted to this production at Hillsboro, to provide a total furnace output from all plants of close to 20,000 tons of lead-free material per annum.

New Jersey

CAMDEN—Fire, Oct. 20, destroyed a portion of the plant of J. Eavenson & Son, Penn St. and the Delaware River, manufacturers of soap products, with loss estimated at close to $375,000, including machinery. It is planned to rebuild in the near future.

LAMBERTVILLE—The Jeperson Newsprint Co., South Union St., is reported to be considering plans for the rebuilding of its local mill, devoted to the manufacture of newsprint papers, partly destroyed by fire, Oct. 20, with loss estimated at close to $300,000. The mill was formerly the property of the Perservance Paper Co., and secured by the Jeperson company several months ago. It has only lately been established and operated. Henry Weeks is general manager.

LAMBERTVILLE—The Lambertville Rubber Co. is perfecting plans for plant expansion to increase the present capacity. Additions will be made in the working force..

SALEM—The Salem Glass Works, Inc., is planning for the immediate rebuilding of the portion of its plant destroyed by fire, Oct. 17. Temporary structures will be erected pending the construction of permanent buildings. The company specializes in the production of glass bottles and jars.

New York

LONG ISLAND CITY—The Liberty Paint Co., 39 10th St., has awarded a general contract to the Commonwealth Engineering Co., 103 Park Ave., New York, for the erection of a 2-story plant, 100x100 ft., on Vernon Ave., near 10th St., estimated to cost about $50,000.

JAMAICA—The Bliss Waterproof Concrete Block Co., 34 Union Hall St., has plans in progress for the erection of a new 1-story plant, 100x200 ft., at Foley and Carroll Sts., estimated to cost approximately $50,000. H. T. Jeffrey, Jr., 308 Fulton St., Jamaica, is architect.

BUFFALO—The Iroquois Natural Gas Co., Iroquois Bldg., has plans nearing completion for the construction of a new 1-story regulator building at 338 Bailey Ave., with installation to include regulators, valves, piping, etc.

BROOKLYN—The Industrial Alcohol Mfg. Co., 90 Wall St., New York, has awarded a general contract to the William Kennedy Construction Co., 215 Montague St., Brooklyn for the erection of a new 2-story plant, 50x92 ft., at 9th and Henry Sts. Work will be placed under way at once.

Pennsylvania

CHESTER—The Stauffer Chemical Co., 624 California St., San Francisco, Calif., has acquired a local tract of land, about 10 acres, heretofore held by the Dantziger Paraffin Co. of America, as a site for an Eastern branch plant. Plans will be prepared at an early date for the initial plant unit, comprising a number of buildings, estimated to cost in excess of $100,000.

LANCASTER—The Burnham Boiler Works, Inc., Ave. A, Irvington-on-Hudson, N. Y., will commence the immediate erection of a new 1-story foundry on the Dillville Rd., to be used in connection with its proposed plant here. The entire works will cost close to $200,000, with equipment. Frank D. Chase, Inc., 645 North Michigan Ave., Chicago, Ill., is engineer.

BLOOMSBURG—Fire, Oct. 13, destroyed the local plant of the Bloomsburg Paper Co., with loss estimated close to $75,000. It is expected to rebuild.

ORVISTON—The Central Refractory Co., Newark, O., has acquired the local plant and property of the Center Brick & Clay Co., with firebrick works at Snow Shoe, near Orviston, and large fireclay deposits in Clinton County. The new owner will continue operations, and purposes making a number of extensions and improvements.

JACOBS CREEK—The S. A. Drug & Chemical Co. is taking bids on a general contract for the construction of a new plant on local site, to cost about $150,000, including machinery. Peter Rosello, 406 Congress Bldg., Detroit, Mich., is the architect. S. J. Ferguson is in charge of company operations.

HUNTINGDON—A portion of the foundry at the plant of the Extension Radiator Works was destroyed by fire, Oct. 18, with loss estimated at about $25,000. The company is operated by the Pierce, Butler & Pierce Mfg. Corp., Syracuse, N. Y.

Tennessee

CHATTANOOGA—The Southern Sheet Steel Co., recently organized with a capital of $1,100,000, has tentative plans under way for the erection of a new plant on local site, consisting of three 60-ton open-hearth furnaces, sheet mill and other buildings, estimated to cost in excess of $400,000, including equipment. W. M. Blecker is president, and W. J. Lynch, vice-president and general manager.

CHATTANOOGA—The Rabe Pipe & Foundry Co., North St. Elmo, Chattanooga, has plans under way for the erection of a new 1-story foundry, 100x150 ft., to be equipped for the most part for the manufacture of iron castings. R. R. Rabe is president and general manager.

Texas

HOUSTON—Walter D. Rogers, 708 Clark St., is organizing a company to establish and operate a local plant for the manufacture of seamless rubber products and other rubber goods. A list of equipment to be installed will be arranged at an early date to include ovens, dipping and forming, machinery, drying equipment, etc.

GORMAN—The Eastland County Gasoline Co., recently organized with a capital of $105,000, has plans in progress for the erection of a 3-unit refining plant, with initial capacity of about 5,000 gal. per day, estimated to cost approximately $80,000. The installation will comprise compressors, high and low pressure pumping machinery, stills, etc. J. T. Purdy heads the company.

OILTON—The Magnolia Petroleum Co., Houston, has plans in progress for the construction of a new storage and distributing plant on local site, estimated to cost in excess of $250,000. The plant will handle the output from the company's property in the Webb-Zapata oilfields.

ROBSTOWN—W. C. Craig, Brownsville, Tex., is organizing a company to construct and operate a local plant for the manufacture of brick, tile and other burned clay products. A site has been selected and work will be placed under way at an early date

Virginia

ROANOKE—J. W. Simpkins, Roanoke, has acquired mica properties in Patrick County totaling about 70 acres. Plans are being formulated for the organization of a company to develop the lands, and establish and operate a complete mill for pulverizing and other service for commercial production.

RICHMOND—The Fiber Board Container Co., manufacturer of fiber products, is planning for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at close to $100,000, including machinery.

Capital Increases, etc.

THE PENNSYLVANIA INDEPENDENT OIL CO., Allentown, Pa., has filed notice of increase in capital from $200,000 to $1,000,000.

THE SOUTHERN CLAY MFG. CO., Chattanooga, Tenn., has filed notice of increase in capital from $300,000 to $1,000,000, for proposed expansion.

THE INDEPENDENT PAPER MILLS, INC., 68 35th St., Brooklyn, N. Y., has filed notice of increase in capital from $100,000 to $200,000.

THE SINCLAIR CONSOLIDATED OIL CORP., 45 Nassau St., New York, N. Y., has arranged for a preferred stock issue of $45,600,000, a portion of the proceeds to be used for improvements and expansion.

THE EBSARY GYPSUM CO., 140 West 42nd St., New York, N. Y., has been increased in capitalization from $40,000 to $80,000, for proposed expansion.

THE BRADSTREET & BRADEN CO. OF DELAWARE, Oklahoma City, Okla., manufacturer of oil products, has filed notice of increase in capital from $65,000 to $100,000.

THE CONSOLIDATED COPPER MINES CO., 120 Broadway, New York, N. Y., has been reorganized, with plant and properties turned over to a new corporation to be known as the Consolidated Copper Mines Corp. William W. Mein is president, and Howard D. Smith, vice-president.

THE INTERCONTINENTAL RUBBER CO., George H. Carnahan, 120 Broadway, New York, N. Y., president, recently reorganized, is arranging for an issue of $2,903,000 in notes, of which $290,300 will be used for expansion and additional working capital.

THE MAMMOTH OIL CO., New York, affiliated with the Sinclair Consolidated Oil Corp., 45 Nassau St., has arranged for a stock issue in excess of $10,000,000, a portion of the proceeds to be used for the development and equipment of oil properties in the Teapot Dome district, Wyo.

New Companies

PETERS & RUSSELL, INC., Boston, Mass., has been incorporated with a capital of $50,000, to manufacture abrasive materials, grinding wheels, etc. Paul S. Peters is president, and Frank H. Russell, 75 Park St., West Roxbury, Mass., treasurer.

THE FINISHING SPECIALTIES & SERVICE CO., 4054 Greenview Ave., Chicago, Ill., has been incorporated with a capital of $25,000, and 250 shares of stock, no par value, to manufacture enamels, varnishes, etc. J. I. and Fred W. McClement, and Philip W. Carston are the incorporators.

THE ROSEBRAND CO., Atlantic City, N. J., care of Joseph B. Perskie, 513 Guarantee Trust Bldg., Atlantic City, representative, has been incorporated with a capital of $125,000, to manufacture chemicals and chemical byproducts. The incorporators are E. and Harold A. Brand, and Louis Rosenthal.

THE JOHN BRUNO CO., New York, N. Y., care of J. A. O'Brien, 1402 Broadway, representative, has been incorporated with a capital of $20,000, to manufacture polishing oils and kindred products. The incorporators are J. B. H. Guest, and H. Markowitz.

E. M. AND F. WALDO, INC., 904-7 Maryland Trust Bldg., Baltimore, Md., has been incorporated with a capital of $500,000, to manufacture chemicals, paints, pigments and affiliated specialties. The incorporators are Edward M. and Frank Waldo.

THE LAVEX CHEMICAL CO., Kansas City, Mo., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are Reynold and O. E. Barnum and W. R. Smith, all of Kansas City.

THE NATIONAL MOTOR CASTINGS CO., South Haven, Mich., has been incorporated with a capital of $250,000, to manufacture iron, steel and other metal castings. The incorporators are F. H. Gallagher, G. H. Wisting and R. B. Campbell, all of South Haven.

THE AIRTITE PAINT CORP., New York, N. Y., care of Avery & Whiting, 5 Nassau St., representatives, has been incorporated with a capital of $10,000, to manufacture paints, varnishes, etc. The incorporators are J. E. Whiting, E. B. Bender and G. O. Castell.

THE REX CHEMICAL CO., Houston, Tex., has been incorporated with a capital of $8,000, to manufacture chemicals and chemical byproducts. The incorporators are W. D. Plunkett, L. J. Jones and W. H. Schopmeyer, all of Houston.

THE EASTERN CHEMICAL CO., 75 Elmdale Ave., Providence, R. I., has filed notice of organization to manufacture chemical products. The company is headed by A. J. Kechigian.

THE H. H. ALLYN RUBBER CORP., Philadelphia, Pa., care of the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia, representative, has been incorporated under Delaware laws, with a capital of $100,000, to manufacture rubber products, automobile tires, etc.

THE PEERLESS PRODUCTS CO., First St., Mt. Washington, Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture varnishes, paints, and kindred products. The incorporators are Charles J. Harris, Floyd T. Macgill and Norman R. Eckard.

THE ACKERMITE CO. OF AMERICA, 130 North Wells St., Chicago, Ill., has been incorporated with a capital of 30 shares of stock, no par value, to manufacture chemicals, special metals, etc. The incorporators are Randolph Thornton, H. Baar and Walter H. Eckert.

THE HARLEM CHEMICAL CORP., care of the Corporation Registry Co., 900 Market St., Wilmington, Del., has been incorporated under Delaware laws, with capital of $500,000, to manufacture chemicals and chemical byproducts.

THE BRASS FOUNDRY CORP., New York, N. Y., care of William Karlin, 132 Nassau St., has been incorporated with a capital of $15,000, to manufacture brass, bronze and other metal castings. The incorporators are L. Stein, J. Schlachter and J. Safer.

THE VALERICINE CHEMICAL CO., Boston, Mass., has filed notice of organization to manufacture chemical specialties. The company is headed by Fred Merrill Drake, 117 Arlington St., Hyde Park, Boston.

THE CHEMICAL PRODUCTS CO., East Chicago, Ind., has been incorporated with a capital of $5,000, to manufacture chemicals and chemical byproducts. The corporators are Marris M., David and S. V. Milgram, all of East Chicago.

THE GRANT PAINT PIGMENT CO., Bensonville, Ill., has been incorporated with a capital of $50,000, to manufacture paint pigments, coloring products, etc. The incorporators are Max Grant and Frank S. Robins. The company representative is Bucklan & Scheuneman, Conway Bldg., Chicago, Ill.

THE BUCKEYE OIL & GREASE CO., Canton, O., has been incorporated with a capital of $25,000, to manufacture oils, greases and kindred products. The incorporators are Elbert J. Smith and David D. Herr.

THE ESSEX TILE CRAFT, INC., Newark, N. J., has been incorporated with a capital of $50,000, to manufacture ceramic tile and kindred products. The incorporators are Leo E. Goddu, L. and William G. Anderson, 241 Summer Ave. The last noted represents the company.

THE NEW ERA CHEMICAL MFG. CO., 416 Belvedere Ave., Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture chemicals, alkalis, etc. The incorporators are R. E. Lee Young, Richard E. Preece and William M. Travers.

THE FEDERAL ALLOY STEEL CORP., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated with a capital of $12,000,000, to manufacture steel and steel alloy products.

THE INTERNATIONAL PAINT CORP., 1214 Walnut Ave., East St. Louis, Ill., has been incorporated with a capital of $50,000, to manufacture paints, linseed oil, white lead and kindred products. The incorporators are H. F. Dreimeyer, C. Pope and C. E. Altrogge.

F. W. WEBER & CO., INC., Keyport, N. J., has been incorporated with a capital of $50,000, to manufacture chemical products. The incorporators are Caspar O. Manx and F. W. Weber, Keyport. The last noted represents the company.

THE O. K. MFG. CO., Philadelphia, Pa., care of A. A. Watson, Dover, Del., representative, has been incorporated under Delaware laws, with a capital of $100,000, to manufacture cement products. The incorporators are H. P. Street, Haverford, Pa.; H. L. Maris, Penfield, Pa.; and J. C. Harrelson, Philadelphia.

THE MERION MAGNESIA CO., Phoenixville, Pa., has been incorporated with a capital of $5,000, to manufacture magnesia products. The incorporators are James Goodall, Samuel Carpenter and Clayton Ullman, 1027 West Bridge St., Phoenixville. The last noted is treasurer and represents the company.

THE PRIMROSE REFINING CO., Wichita Falls, Tex., has been incorporated with a capital of $100,000, to manufacture refined oil products. The incorporators are H. J. Stief and S. J. Brin, both of Wichita Falls.

THE ALLEGHENY CHEMICAL MFG. CO., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., has been incorporated under Delaware laws with capital of $100,000, to manufacture chemicals and chemical byproducts, waterproofing materials, etc.

THE KRASCO MFG. CO., 451 East Ohio St., Chicago, Ill., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture metals and metal alloys. The incorporators are Eric L. Anderson, Paul N. Dale and Frank J. Dowd.

THE CORKSTONE PRODUCTS CORP., 121-23 North Collington Ave., Baltimore, Md., has been incorporated with a capital of $25,000, to manufacture oxide-chloride cement products, composition specialties, etc. The incorporators are Leon H. Grossman, I. Weinberg and Solomon C. Berenholtz.

GEORGE A. MOLLESON & CO., INC., New York, N. Y., care of C. H. Molleson, 165

Broadway, representative, has been incorporated with a capital of $50,000, to manufacture oils, greases, etc. The incorporators are G. A. and S. H. Molleson, and W. A. Bunta.

THE SNOWDRIFT SOAP CO., care of the Colonial Charter Co., Ford Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with a capital of $250,000, to manufacture soaps, washing powders, etc.

THE INTERNATIONAL OIL CO., Lombard and 9th Sts., Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture and deal in oil products. The incorporators are Morris Zemil and Louis Wolach.

Industrial Developments

GLASS—The Dunkirk Window Glass Co., Dunkirk, South Charleston, W. Va., has resumed operations at its plant after a shut-down of close to 4 months. About 200 men will be employed for the present, with early increase in working force in the future. The company is said to have orders on hand for at least 4 months continuous production.

Machine-operated window glass plants in Pennsylvania, West Virginia, Indiana and other parts of the coutnry are now running on a full 25-hour day basis giving employment to normal working forces. It is said that the demand insures production on this schedule for a number of months to come.

The United States Sheet & Window Glass Co., Shreveport, La., has placed its local plant in operation. It has recently been completed at a cost of about $1,000,000, and has provisions for a full working force of about 500 men. It is expected to advance production to this point at an early date.

LEATHER — The Griess-Pfleger Tanning Co., Natick, Mass., has advanced operations to a full production basis at its local plant.

The Ohio Leather Co., Girard, O., is running at full capacity at its local calfskin tannery, with employment of regular working force.

The Continental Leather Co., Bridesburg, Pa., has production under way on close to capacity basis at its local tannery, and carload shipments are now leading the plant.

The Lorraine Tanning Co., Peabody, Mass., formerly known as the Webber-Laemmle Tanning Co., is operating at close to normal at its tannery.

RUBBER—The Perfection Tire & Rubber Co., Fort Madison, Ia., is running on a basis of 1,200 tires a day, and will maintain this schedule for an indefinite period.

The Firestone Tire & Rubber Co., Akron, O., is planning to place its new rim plant in operation at an early date. The factory is now nearing completion and will have a rated capacity of 20,000 passenger car tire rims and 4,000 solid truck tire rims per day, said to be the largest plant of its kind in the world. A large working force will be employed.

The Seiberling Rubber Co., New Castle, Pa., is maintaining capacity production at its local plant, with full operating schedule also prevailing at its Ohio mills. Business is said to be averaging $500,000 per month.

The Kelly-Springfield Tire Co. is holding to capacity output at its Akron, O., plant, with production at the Cumberland, Md., mill at a point as high as labor supply will permit. There is said to be a scarcity of men in this section, necessitating the use of ordinary labor and giving a course of training. Current production at the plants is on a basis of 6,000 tire casings per day, with a relatively large output of tubes and solid tires.

IRON AND STEEL—The National Enameling & Stamping Co. has advanced production to close to normal at its steel sheet mills at Granite City, Ill., after a partial shutdown through the summer and early fall; 14 mills have recently been placed in service.

The Phoenix Iron Co., Phoenixille, Pa., has 5 furnaces in operation for the first time in the past 4 years. Production has been increased in the different operating departments and orders on hand insure continuance on the present basis for some time to come. The company has advanced the wages of laborers at the plant 40 cents a day, making a rate of $3.15 a day; skilled operatives have also received an increase.

The Jones & Laughlin Steel Co., Pittsburgh, Pa., has blown in the last of its Aliquippa group of blast furnaces at Woodlawn, Pa., making 11 out of 12 stacks in active operation. The last furnace, one of the Eliza group, is expected to go into blast at an early date giving 100 per cent operation for the first time in a number of months.

The Sloss-Sheffield Steel & Iron Co. has repairs under way at one of its blast furnaces at North Birmingham, Ala., requiring from 2 to 3 weeks. Shortly thereafter the unit will be blown in.

The Alan Wood Iron & Steel Co., Philadelphia, Pa., is planning to blow in its No. 3 blast furnace about the middle of November.

Steel mills at Gary, Ill., are now running on the basis of about 80 per cent of capacity, and are held at this point through labor shortage. It is said that the plants would employ at least 2,000 additional men if they were available. With the continued labor scarcity, it is said that another increase in wages likely will be made in the near future to hold present employees.

The Whitaker-Glessner Co. is running under heavy output at its hot mills at the Wheeling and Beech Bottom, W. Va., and Martins Ferry, O., plants. The wages of employees have recently been advanced 10 per cent.

The Falcon Steel Co., Niles, O., is said to be planning for the early resumption of operations at four of its sheet mills, recently closed down on account of car shortage.

METALS—The Eagle-Picher Lead Co., has advanced operations to a full capacity basis at its Henryetta, Okla., smelting plant, with day and night shifts. Five roasters and 6 blocks are in service.

The Success Mining Co., Wallace, Idaho, is advancing production at its local concentrating mill, and it is expected to give employment to 3 operating shifts at an early date. Production is devoted to lead and zinc, with small silver showings.

The Butte & Superior Co., Butte, Mont., is increasing production at its properties and is now shipping on a basis of 8,000,000 lbs. of concentrates a month to the zinc electrolytic plant of the Anaconda Copper Mining Co., at Great Falls, Mont.

The National Cast Iron Pipe Co., Birmingham, Ala., is arranging to increase operations about 50 per cent at its plant, including the installation of considerable special equipment.

The Bunker Hill & Sullivan Mining Co., Kellogg, Idaho, has blown in the second furnace at its local smelting plant, and plans to operate on the present basis for an indefinite period.

MISCELLANEOUS—The Hudsondale Ochre Works, Hudsondale, Pa., is planning for the early resumption of operations at its local plant, following a suspension caused by car shortage.

The Dill & Collins Co., Philadelphia, Pa., manufacturer of paper, is running on a 24-hour day working schedule at its local mills. It is planned to continue on this basis for an indefinite period.

The Sapulpa Refining Co., Sapulpa, Okla., is operating its local oil refinery on a basis of 5,000 bbl. per day. The plant has a rated output of 7,000 bbl., and it is planned to advance production in the near future.

The Diamond State Fiber Co., Bridgeport, Pa., is maintaining operations on a full-capacity schedule at its local plant, with employment of regular working force. An increase has recently been made in the wages of skilled operatives and laborers, ranging from 2 to 5 cents per hour.

New Publications

NEW U. S. GEOLOGICAL SURVEY PUBLICATIONS: Mineral Resources of the United States in 1921 (preliminary summary), introduction by G. F. Loughlin and statistics assembled by Martha B. Clark, published Sept. 14, 1922; I: 7, Manganese and Manganiferous Ores in 1921, by H. A. C. Jenison (Mineral Resources of the U. S., 1921, Part I), published July 8, 1922; I: 8, Lead and Zinc Pigments and Salts in 1921, by C. E. Siebenthal and A. Stoll (Mineral Resources of the United States, 1921, Part I), published July 10, 1922; I: 9, Bauxite and Aluminum in 1921, by James M. Hill (Mineral Resources of the United States, 1921, Part I), published Aug. 1, 1922; II: 7, Salt in 1921, by G. F. Loughlin and A. T. Coons (Mineral Resources of the U. S., 1921, Part II), published June 29, 1922; II: 8, Strontium in 1921, by George W. Stose (Mineral Resources of the U. S., 1921, Part II), published July 5, 1922; II: 9, Carbon Black Produced From Natural Gas in 1921, by E. G. Sievers (Mineral Resources of the U. S., 1921, Part II), published July 5, 1922; II: 10, Fluorspar and Cryolite in 1921, by Hubert W. Davis (Mineral Resources of the United States, 1921, Part II), published July 6, 1922; II: 11, Potash in 1921, by M. R. Nourse (Mineral Resources of the U. S., 1921, Part II), published July 10, 1922; II: 12, Phosphate Rock in 1921, by K. W. Cottrell (Mineral Resources of the U. S., 1921, Part II), published July 11, 1922; II: 12, Asphalt and Related Bitumens in 1921, by K. W. Cottrell (Mineral Resources of the U. S., 1921, Part II), published July 26, 1922; II: 14, Mica in 1921, by B. H. Stoddard (Mineral Resources of the U. S., 1921, Part II), published Aug. 3, 1922; II: 15, Magnesite in 1915, by Charles G. Yale (Mineral Resources of the U. S., 1921, Part II), published Aug. 5, 1922; II: 16, Gypsum in 1921, by K. W. Cottrell (Mineral Resources of the U. S., 1921, Part II), published Aug. 4, 1922; II: 17, Talc and Soapstone in 1921, by Edward Sampson (Mineral Resources of the U. S., 1921, Part II), published Aug. 4, 1922; II: 18, Clay in 1921, by Jefferson Middleton (Mineral Resources of the U. S., 1921, Part II), published Sept. 20, 1922; II: 19, Feldspar in 1921, by Frank J. Katz (Mineral Resources of the U. S., 1921, Part II), published Aug. 30, 1922; II: 20, Salt, Bromine and Calcium Chloride in 1921, by K. W. Cottrell (Mineral Resources of the U. S., 1921, Part II), published Aug. 31, 1922; II: 22, Asbestos in 1921, by Edward Sampson (Mineral Resources of the U. S., 1921, Part II), published Sept. 19, 1922; II: 32, Asbestos in 1921, by Edward Sampson (Mineral Resources of the U. S., 1920, Part II), published July 7, 1922; II: 33, Clay-Working Industries, Clay and Silica Brick in 1919 and 1920, by Jefferson Middleton (Mineral Resources of the U. S., 1920, Part II), published Aug. 14, 1922.

Organic chemists will find of interest and value the recent publication of the National Research Council, entitled "Organo Magnesium Compounds in Synthetic Chemistry," "A Bibliography of the Grignard Reaction, 1900 to 1921," by Clarence J. West and Henry Gilman. In addition to a comprehensive compilation of 1,485 separate references and an equally comprehensive index by compounds the bulletin contains a very interesting descriptive chapter of the Grignard reaction. Subheads in this chapter include a historical statement, the preparation of the Grignard reagent, its constitution and its reactions, and finally its use in the preparation of hydrocarbons, alcohol ethers, aldehydes, ketones, acids, esters, nitriles and certain inorganic compounds. This bulletin is published as Reprint and Circular Series No. 24 and sells for $1.50.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting April 3 to 7, 1923, at New Haven, Conn.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at Richmond, Va., Dec. 7 to 9.

INTERNATIONAL CHAMBER OF COMMERCE will hold its second general meeting in Rome, Italy, March 19-26, 1923.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

The following meetings are scheduled to be held in Rumford Hall, Chemists' Club, 52 East 41st St., New York City Nov. 10—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting. Nov. 17—American Electrochemical Society, regular meeting. Dec. 1—Society of Chemical Industry, regular meeting. Dec. 8—American Chemical Society, regular meeting. Jan. 5—American Chemical Society, regular meeting. Jan 12—Society of Chemical Industry, Perkin Medal. Feb. 9—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting. March 9—American Chemical Society, Nichols Medal. March 23—Society of Chemical Industry, regular meeting. April 20—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting. May 4—American Chemical Society, regular meeting. May 11—Société de Chimie Industrielle (in charge), American Chemical Society, American Electrochemical Society, Society of Chemical Industry, joint meeting, May 18—Society of Chemical Industry, regular meeting. June 8—American Chemical Society, regular meeting.